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January 7, 2005

bcc: O.L. Lomax (M-643)
JCP/KWL/FLP/MJS
File: WQ 3.6.6

Mr. Peter Goode
Missouri Department of Natural Resources
Water Pollution Control Program, Permit Section Chief
PO Box 176
Jefferson City, MO 65102-0176

Ameren

Re: AmerenUE Meramec Power Plant
NPDES Permit MO-0000361
316(b) Phase II Proposal for Information Collection

Dear Mr. Goode:

This letter and attached plan represent the Proposal for Information Collection (PIC) to support development of the Comprehensive Demonstration Study for the AmerenUE Meramec Power Plant in accordance with the provisions of 40 CFR 125.95(b)(1).

The Meramec Power Plant cooling water intake structure (CWIS) is located on the Mississippi River and has a design CWIS flow of 1,044 cubic feet per second (cfs). The mean annual flow of the Mississippi River during the 1958-2003 period is 202,240 cfs, as recorded at the United States Geological Survey Gage Station 0701000 located at St. Louis, Missouri. Our review of the Mississippi River and the Meramec Power Plant determined that this facility is only subject to the impingement standard of the Rule, as the facility CWIS design flow is less than five percent (0.51%) of the average Mississippi River flow. It is our intention to begin collection of biological field impingement data on or about April 1, 2005.

According to EPA regulations the PIC must contain the following items as summarized below:

- ☐ A description of proposed and/or implemented technologies, operation measures, and/or restoration measures to be evaluated by the study.
- ☐ A list and description of any historical studies characterizing impingement mortality and entrainment and/or the physical and biological conditions in the vicinity of the cooling water intake structures
- ☐ A summary of any past or ongoing consultations with appropriate fish and wildlife agencies that are relevant to this study.
- ☐ A sampling plan for new field studies.

Each of these items are subsequently addressed.

Description of proposed and/or implemented measures to be evaluated

We plan to evaluate an appropriate range of technologies, operational, and/or restoration measures as part of the comprehensive demonstration study as a means of reducing impingement mortality. However, it is impossible to provide a complete and accurate list of all measures at this time due to the complex engineering, operational and biological evaluations required of each intake structure and the short time frames provided within the rule to meet PIC submittals. Some illustrative examples of measures to be evaluated for technologies include coarse-mesh Ristroph Screens, retrofit of intake bar racks and cylindrical wedge wire screens. Appropriate operational considerations such as reducing the number of pumps operating during certain times of the year may also be assessed. To the extent restoration represents an appropriate and viable alternative, consideration may be afforded to fish stocking or habitat protection program participation. All measures to be evaluated will be subject to cost-cost and/or cost-benefit criteria and the potential procurement of a site-specific standard, as afforded by the Rule.

Historical Impingement Studies

During July 1976 the Meramec Power Plant submitted a study that demonstrated that the CWIS had little, if any, impact on the waterbody ecology. Data generated from this 1974-1975 study determined that 96.6% percent of the species impinged by the CWIS were Gizzard Shad and Freshwater Drum. This Study was approved by the Missouri Department of Natural Resources in September 1977.

Attached to this letter is an impingement sampling plan for Meramec Plant. Additional details on the physical aspects of the intake structure, historical site impingement studies and information on fish and shellfish community are summarized in Chapters 2 and 3 of the plan to meet the requirements of this item.

Relevant Past/ongoing Resource Agency Consultations

Currently, there are no past or ongoing consultations with fish and wildlife resource agencies that would be relevant to this study. We anticipate that discussions with such agencies may be necessary as we precede though the regulatory process.

Proposed Sampling Plan for New Field Studies

We propose to update existing impingement data to reflect current conditions in the river and plant operation. The proposed impingement monitoring plan and

quality assurance plan are included in Chapters 4 & 5 of the attached document. In summary, we plan to conduct a one year impingement sampling program. Samplings will occur over one 24-hour period at a biweekly frequency. Pending the outcome of the initial one-year sampling effort, we may elect to perform additional focused studies.

As mentioned previously, it is our intent to begin field studies on or about April 1, 2005 in order to support development of the required Comprehensive Demonstration Study. As it is critical that we obtain Agency approval prior to beginning field studies, we respectfully request that the Agency validate our plan as expeditiously as possible. Consistent with regulatory requirements, it is our intent to submit the Comprehensive Demonstration Study for the CWIS by January 7, 2008.

We believe the information provided meets the regulatory requirements of the PIC. If you have any questions regarding this Proposal for Information Collection, please contact me (314-554-4581) or John Pozzo (314-554-2280).

Sincerely,

Michael J. Smallwood
Senior Environmental Engineer

Enclosure

cc: Mr. Richard Laux, MDNR
Mr. Tim Stallman, MDNR
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SAMPLING PLAN FOR THE IMPINGEMENT MORTALITY CHARACTERIZATION STUDY AT THE MERAMEC POWER PLANT

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December 2004

SAMPLING PLAN SUMMARY

An impingement mortality sampling plan is proposed for the Meramec Power Plant, a 932-MW(e) facility in St. Louis County, Missouri, located along the Mississippi River approximately 16 miles south of the city of St. Louis. The station is subject to the Clean Water Act §316(b) Phase II Rule for its NPDES permit, which requires that impingement mortality be reduced by 80 to 95 percent, compared to a baseline level specifically determined for the facility. To comply with this Rule, the proposed sampling plan will provide information required to complete an Impingement Mortality Characterization Study for submission with its NPDES permit application. This sampling plan: 1) identifies existing data on the fish community in the vicinity of the cooling water intake and on impingement occurring at the intake; 2) evaluates the sufficiency of these data to characterize current fish abundance, distribution, and impingement mortality at the intake; 3) makes a preliminary selection of Representative Species for detailed study; and 4) describes a work scope for impingement monitoring.

The Phase II Rule allows impingement mortality to be quantified using Representative Species (RS), chosen to be surrogates for other species not selected for detailed study. RS typically are those most frequently observed in impingement collections, or those deemed to be most important because of their economic value (e.g., commercially or recreationally exploited species), value to the ecosystem (e.g., abundant prey species), or societal value (e.g., threatened or endangered species). Based on impingement studies conducted during 1974-1975, the recommended list of RS includes gizzard shad, freshwater drum, common carp, bluegill, white bass, paddlefish, flathead catfish, and sauger. The gizzard shad is recommended as an RS due to its dominance (approximately 95 percent) of the total impingement. The remaining seven species are recommended because of their specific value to the community and as surrogates for their respective taxonomic families.

The cooling water intake screening configuration has changed from conventional traveling screens to dual-flow traveling screens since impingement was last monitored in the 1970's. The fish community in the middle Mississippi River may have changed sufficiently since the 1970's to affect the species composition and magnitude of impingement at the station. For these reasons, an impingement monitoring program is proposed that will update existing impingement data to reflect current conditions in the river and current operation of the station. Data produced by this program will define the species and life stages impinged, as well as their numbers and biomass on a time (biweekly, monthly, and annual) and per-volume-pumped (MG of cooling water) basis.

The table below summarizes the proposed features of the impingement mortality sampling programs.

MERAMEC POWER PLANT SAMPLING PROGRAM SUMMARY

Program	Duration	Sampling Frequency	Data Collected
Impingement Monitoring	1 year	Biweekly over a 24-hour period, year-round	Counts and biomass by species and life stage, length frequency, scale/otolith samples of RS, specimen condition, collection efficiency, ancillary environmental and operation data

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1. INTRODUCTION

ASA Analysis & Communication, Inc. has prepared this Impingement Mortality Sampling Plan for Ameren's Meramec Power Plant (Meramec), located on the west bank of the Mississippi River, 16 miles south of St. Louis, Missouri. This plan is a component of the Proposal for Information Collection being submitted as part of the application process for a NPDES permit from the Missouri Department of Natural Resources (MoDNR). Under the Clean Water Act §316(b), an NPDES permit applicant must demonstrate that the location, design, construction and capacity of its cooling water intake structure represents Best Technology Available (BTA) for minimizing adverse environmental impact. The primary impacts of concern under §316(b) are entrainment of smaller aquatic organisms into the cooling water system or impingement of larger organisms onto traveling screens in the cooling water intake. However, other impacts associated with various technology or operating alternatives also are considered in reaching a BTA decision.

1.1 PHASE II §316(b) REQUIREMENTS

On July 9, 2004, the U.S. Environmental Protection Agency (EPA) published its final Phase II Rule under CWA §316(b). Phase II applies to existing electric generating facilities (construction commenced prior to January 17, 2002) that have cooling water intake structures (CWIS) with a design capacity of 50 million gallons per day (MGD), withdraw water from waters of the U.S., and use 25 percent or more of the water withdrawn for cooling purposes. The Meramec Power Plant fits this definition for a Phase II facility. Compliance with the Phase II Rule is based on achieving performance standards for reduction of impingement mortality and entrainment set by the EPA on the basis of facility location. The Rule requires that impingement mortality be reduced by 80 to 95 percent compared to a baseline level (i.e., the calculation baseline) specifically determined for the facility. However, Meramec is not subject to entrainment reduction performance standards because its design intake flow is 5 percent or less of the mean annual flow of the Mississippi River. The design intake flow is 1,044 cfs and the mean annual flow was 204,240 cfs for the period from 1958 through 2003 at the USGS Gage #0701000 in St. Louis (Alden 2004). Entrainment therefore will not be considered further in this plan.

The calculation baseline is a hypothetical condition representing an intake structure located at the surface and along the shoreline of the source waterbody. The hypothetical intake would have the screen face parallel to the shoreline and traveling screens with the standard 3/8-inch mesh. No prior modifications to the configuration or operation of the intake would have been taken for the purpose of reducing impingement mortality or entrainment.

Under the Phase II Rule, plant operators must comply with the performance criteria by demonstrating that their existing CWISs:

1. Presently comply with these standards (commensurate with a closed-cycle, recirculating cooling water system) or have a design intake velocity $\leq$0.5 fps (relevant to impingement mortality reduction only), known as EPA Compliance Alternative #1;
2. Already comply under existing conditions or will comply after implementation of technology, operational, and/or restoration measures designed to reduce or replace impingement and entrainment losses (EPA Compliance Alternatives #2 and #3, respectively); or

3. Will meet site-specific standards set in lieu of the national standards because of implementation costs "significantly" higher than considered by the EPA or than the derived benefits (EPA Compliance Alternative #5).

The Rule also allows for reduced study requirements if an approved technology (currently limited to submerged wedge-wire screens) is implemented (EPA Compliance Alternative #4).

Besides other documents required with the submission of a permit application, the Rule requires development of a Comprehensive Demonstration Study (CDS), unless the applicant can demonstrate that its facility's intake cooling water flow is commensurate with a closed-cycle recirculating system (EPA Compliance Alternative #1). The CDS has several components, as outlined in Table 1-1. One component is a Proposal for Information Collection, which includes a sampling plan for any proposed field studies necessary to supplement existing information about the source waterbody, its fish and shellfish community, or current impingement mortality and entrainment rates. If it is determined that existing information might not accurately represent current impingement mortality and entrainment rates, the sampling plan will address proposed sampling for the Impingement Mortality (IM) Characterization Study, a required component of the CDS. This Impingement Mortality Sampling Plan fulfills this requirement for the Meramec Power Plant. Additional biological monitoring might be desirable depending on the specific compliance approach being used. Given that a compliance approach for Meramec has not yet been selected at this early stage in the planning process, plans for such additional studies are not included in this document.

1.2 IM CHARACTERIZATION STUDY

The IM Characterization Study is an integral part of the CDS and the overall determination of BTA compliance. The IM Characterization Study provides information needed for development of all subsequent parts of the CDS, including the Design and Construction Technology Plan, the Technology Installation and Operation Plan, the Restoration Plan (optional), a site-specific determination of BTA (if justified), and ultimately the Verification Monitoring Plan (Table 1-1). The IM Characterization Study provides data on the rates of impingement mortality (and entrainment, when applicable) currently occurring at the plant, as well as a foundation for estimating the calculation baseline, needed for determining the levels of impingement mortality (and entrainment) reduction being achieved at the plant, presently and in the future. The Rule requires that the IM Characterization Study provide:

1. Taxonomic identifications of all life stages of fish, shellfish, and protected species in the vicinity of the CWIS and susceptible to impingement;
2. A characterization of these species and life stages in terms of their abundance and their spatial and temporal distribution, sufficient to characterize the annual, seasonal and diel variations in impingement mortality; and
3. Documentation of current impingement mortality of these species and life stages.

In addition to these basic requirements, the IM Characterization Study can provide information necessary for the permit applicant to choose the appropriate Rule compliance alternative, such as applying for a site-specific determination of BTA. To justify this alternative, the results of the IM Characterization Study are needed to evaluate the benefits of implementing technology, operational, or restoration measures, in terms of the numbers or biomass of fish and shellfish potentially saved by their implementation.

The Phase II Rule allows impingement mortality and entrainment to be quantified either for all taxa or through the use of Representative Species (RS) as part of the compliance assessment. Representative Species are chosen to be surrogates for other species not selected for detailed study. Representative Species typically are those most frequently observed in impingement and entrainment collections, or those deemed to be most important because of their economic value (e.g., commercially or recreationally exploited species), value to the ecosystem (e.g., abundant prey species), or societal value (e.g., threatened or endangered species). Since biological information necessary to complete analyses for the CDS are not available for all species, we believe it is both more practical and more technically defensible to base all analyses on Representative Species. In this sampling plan, we provide the technical rationale for a preliminary selection of Representative Species.

1.3 SAMPLING PLAN OBJECTIVES AND ORGANIZATION

This Impingement Mortality Sampling Plan has been prepared to meet the following objectives:

1. To identify and summarize existing data on the fish and shellfish community in the vicinity of the plant's CWIS;
2. To identify and summarize existing data on fish and shellfish impingement within the plant's CWIS;
3. To evaluate the sufficiency of existing data to describe the current fish abundance and spatial and temporal distribution of fish in the vicinity of the plant's CWIS, and the current rates of impingement mortality;
4. To make an initial selection of Representative Species; and
5. To prepare a work scope for a monitoring program required to supplement existing information on impingement mortality at Meramec.

This sampling plan is being submitted to the MoDNR as part of Ameren's Proposal for Information Collection (PIC) for the Meramec Power Plant. The Phase II Rule encourages the MoDNR to review and comment on the PIC within a 60-day period, although sampling may begin during this period.

This sampling plan is organized to first present background information on the plant, including the source waterbody (Section 2.1), the cooling water intake design and operation (Section 2.2), historical biological data (Section 2.3), and a discussion of the need for supplemental data for the IM Characterization Study (Section 2.4). Section 3 then describes the fish community in the vicinity of the plant's CWIS, using available historical data. Section 3 also briefly summarizes life history information for Representative Species, with an emphasis on how their life history influences their exposure to impingement at Meramec. Section 4 describes the recommended sampling scope for impingement monitoring. This program work scopes describes the recommended sampling design, sampling gear and its deployment, sample processing procedures, collection of any required ancillary information, and data analysis. Section 5 describes a quality assurance program that will address data quality concerns.

Table 1-1 EPA's Comprehensive Demonstration Study (CDS) Requirements

Requirement
Proposal for Information Collection
A description of the selected combination of intake technologies, operational measures, and/or restoration measures being evaluated
A list and description of previous impingement/entrainment studies and/or studies on the physical or biological conditions in the vicinity of the CWIS and their relevance to the study
A summary of past or on-going consultations with federal, state, or tribal fish and wildlife agencies and a copy of written comments
A sampling plan for any new field studies proposed and documenting: • methods proposed and those used in similar studies in the same source water body • quality assurance/quality control procedures • description of the study area (including the zone of influence of the CWIS) • taxonomic identification of the sampled or evaluated biological assemblages (including all life stages of fish and shellfish)
Source Water Body Flow Information
CWIS on a freshwater stream or river: • annual mean flow and all supporting documentation and engineering calculations necessary to determine percentage of water body flow utilized by a facility
CWIS on a lake (other than one of the Great Lakes) or reservoir with a proposed increase to the design intake flow: • narrative description of the thermal stratification • any documentation and engineering calculations necessary to show that natural thermal stratification will not be disrupted
Impingement Mortality and Entrainment Characterization Study
Taxonomic identification of the species and life stages of fish and shellfish in the vicinity of the CWIS that are most susceptible to impingement and entrainment
A characterization of the species most susceptible to impingement and entrainment including the abundance and temporal/spatial characteristics
If new information is needed to characterize IM&E, studies must be "of a sufficient number of years…to characterize annual, seasonal, and diel variations."
Samples used to support calculations of reduction of impingement mortality and entrainment; calculation of benefits must be conducted during periods of representative operational flows and flows must be documented
Documentation may include historical data that are representative of the current operation and biological conditions
Identification of threatened or endangered species protected under Federal, State or Tribal law

Table 1.1 (continued)

Design and Construction Technology Plan
Capacity and utilization rate of the facility and supporting documentation including: • average annual net generation of the facility over a 5 year period (if available) of representative operating conditions • total net capacity of the facility • calculations
Explanation of the technologies and operational measures being used or to be employed to meet § 125.94
A narrative description of the design and operation of all design construction technologies or operational measures necessary to meet national performance standards, and information that documents the efficacy for application with the species and life stages expected to be most susceptible to impingement and entrainment (include all design calculations, drawings, and estimates to support descriptions)
Calculations of the reduction of impingement mortality and entrainment of all life stages of fish and shellfish that would be achieved with the technologies or operational measures being adopted based on the Impingement Mortality and Entrainment Characterization Study described above (include all design calculations, drawings, and estimates to support descriptions)
Documents demonstrating that the location, design, construction and capacity of the CWIS technologies reflect BTA
Technology Installation and Operation Plan
A schedule for installation and maintenance of any new design and construction technologies
A list of operational parameters that will be monitored, including location and monitoring frequency
A list of activities to ensure the efficacy of the installed design and construction technologies and operational measures, to the degree practicable, and the implementation schedule
Schedule and methodology for assessing efficacy of the measures in achieving applicable performance standards, including an adaptive management plan for revisions if the standards are not being met
For pre-approved technologies (Compliance Alternative 4), documentation that appropriate site conditions exist for the technologies
Information to Support Restoration Measures
Explanation of why restoration measures would be more feasible, cost-effective, or environmentally desirable than by meeting performance standards or site-specific requirements wholly through use of design and construction technologies, and/or operational measures
A list and narrative description of the restoration measures in place or proposed for implementation, including species targeted
Quantification of the ecological benefits (production of fish and shellfish) from existing and/or proposed restoration measures, as well as a discussion of the nature and magnitude of uncertainty associated with the restoration measures and a discussion of the time frame for accrual of these benefits
Design calculations, drawings, and estimates documenting that the restoration measures, alone or in combination with technology or operational measures, will meet the requirements for production of fish and shellfish

Table 1.1 (continued)

An adaptive management plan to include: • a monitoring plan listing parameters that will be monitored, and describing the frequency of monitoring and criteria for determining success • list of activities to ensure efficacy of the restoration measures, the linkages between these activities and items in the monitoring plan, and an implementation schedule for the activities • a process for revising the plan if new information becomes available or if standards or site-specific requirements are not being met
A summary of past or on-going consultations with Federal, State, or Tribal fish and wildlife agencies and a copy of written comments
If requested, a peer review of items to be submitted as part of the restoration plan
A description of information to be included in a biannual status report
• **Information to Support Site-Specific Determination of BTA**
Comprehensive Cost Evaluation – including detailed engineering cost estimates of the technological or operational modifications proposed in the Design and Construction Plan above
Valuation of the Monetized Benefits of Reducing Impingement and Entrainment (if the site-specific determination is being sought because the costs are significantly greater than the benefits) containing: • description of methodology used • the basis for any assumptions and quantitative estimates • analysis of the effects of significant sources of uncertainty on the results
Site-Specific Technology Plan containing: • a narrative description of the technologies, operational measures, and restoration measures that you have selected and information that demonstrates the efficacy of the technology for species in the vicinity of the CWIS and supporting design calculations, drawings, and estimates • engineering estimate of the efficacy of the technological or operational measures for reducing impingement and entrainment – include site-specific evaluation of the suitability of the technologies or operational measures for reducing IM&E based on representative studies and/or prototype studies and supporting design calculations, drawings, and estimates • documentation that demonstrates the technologies, operational measures, or restoration measures selected would satisfy §125.94 (establishment of BTA) Most of this information will be developed in the Design and Construction Technology Report
Verification Monitoring Plan – two years of monitoring to verify full-scale performance of technologies, operational measures, or restoration)
Plan must include: • frequency of monitoring • duration of monitoring • description of yearly status report to be submitted to the Director

2. BACKGROUND INFORMATION

This section presents a summary of available information on the Meramec Power Plant regarding its source waterbody (Mississippi River), the design and operation of the facility, and previous biological studies at the plant and in the source waterbody.

2.1 SOURCE WATERBODY

The Meramec Power plant is located in St. Louis County, Missouri on the west bank of the Mississippi River at River Mile (RM) 161.4, immediately north of the confluence of the Meramec River and 16 miles south of the city of St. Louis (Figure 2-1). This area of the Mississippi River is considered part of the Upper Mississippi River (UMR), defined as the 926-mile reach extending from the confluence of the Ohio River at Caruthersville, Missouri northward to the confluence of the St. Croix River at Hastings, Minnesota (Rasmussen and Pitlo 2004a). More specifically, the plant location is near the upstream end of the river reach sometimes called the Middle Mississippi River (MMR), which is bounded upstream by the confluence of the Missouri River and downstream by the confluence of the Ohio River.

The MMR and the Lower Mississippi River or LMR (from the confluence of the Ohio River southward to the Gulf of Mexico) are characterized as the “open reach” or “unimpounded reach” of the river. Unlike the “pooled reach” of the UMR north of the Missouri River confluence, the MMR and LMR do not have dams and locks constructed by the U.S. Army Corps of Engineers (USACE) for navigation purposes. Instead, the MMR has been channelized and has river flow control devices that have evolved over the last two centuries to restrict the river flow to the main navigation channel, prevent river meandering, and control the deposition of sediments (Rasmussen and Pitlo 2004a). These devices include wing dikes that direct the river flow toward the main channel; closing dams placed at the upstream end of side channels to shut off their flow, riverbank revetments to protect against bank erosion, and bendway weirs to scour sediments from places of natural accretion. In addition, levees have been constructed along this reach to prevent floodwaters from entering the floodplain, thus restricting the course of the river flow and modifying the river’s natural hydrograph. Maintenance of the navigational channel has required periodic dredging, and placement of the dredge spoils into off-channel areas within the river course has further modified the river features and habitats.

River flow at the Meramec Power Plant, as measured at the St Louis gaging station (USGS 07010000) 18 miles upstream from the plant since 1958 (when the last major upstream flow regulating facility was installed), has ranged from 34,600 cfs to 1,070,000 cfs. This maximum daily flow, recorded on August 1, 1993, represented a 500-year flood event (Rasmussen et al. 2004). Mean annual flow during the 10-year period from 1993 through 2002 ranged from 134,000 cfs in 2000 to 439,100 in 1993. At a flow of 150,000 cfs, the river is approximately 2,300 feet wide in the vicinity of the plant’s intake, and at the low flow of 34,600 cfs the river is approximately 1600 feet wide there. Corresponding average river velocities at these discharges in the vicinity of the intake would be 3.3 fps and 2.2 fps, respectively (UEC 1977).

2.2 INTAKE DESIGN AND OPERATION

The Meramec Power Plant consists of four single-boiler, single-turbine generator units. Units 1 and 2 are each rated at a maximum design capacity of 142 MW and were placed into service in 1953 and 1954, respectively. Unit 3 began service in 1958 and is rated at

289 MW. Unit 4 began service in 1961 and is rated at 359 MW. All units are fueled by pulverized coal and utilize once-through cooling. In recent years the plant has operated in a load-following capacity at a 59 percent capacity.

The plant's cooling water intake structure is built out into the river from the shoreline and at high river stages can be surrounded by water. It consists of four cells, one for each unit. Within each cell are two wells. For Units 1 and 2, water enters the 52 foot-deep wells through 7-foot-high bottom-oriented openings equipped with trash racks consisting of bars with 4.5-inch spacing on center. For Units 3 and 4, the bottom-oriented openings are 11 feet wide by 13 feet high and they are protected by trash racks with identical bar spacing. Each well contains a dual-flow vertical traveling screen (dual-entry, single-exit) fitted with 4-foot wide baskets for Units 1 and 2 and 5-foot wide baskets for Units 3 and 4. Mesh size on all screens is 1/2-inch square. Each well supplies water to a circulating water pump, rated at 45,000 GPM each for Units 1 and 2; 63,000 GPM each for Unit 3; and 81,200 GPM each for Unit 4, for a total rated capacity of 506,000 GPM for all pumps combined.

Screen rotation for all units can be controlled either manually or automatically by pressure differential sensor, and can operate at high or low speeds (20 fpm or 5 fpm) depending on the debris loading. Under automatic operation, the screens rotate for 15 minutes every hour. A 2-foot pressure differential causes the screens to rotate at high speed (20 fpm) until the differential becomes 1 foot, when it reverts to a slow speed rotation. A 3-foot-differential results in a fast speed rotation until the pressure differential drops to 18 inches, when it reverts to slow speed rotation. Units 1 and 2 use a high pressure spray wash and Units 3 and 4 use a low pressure spray wash. Operating at maximum capacity and low water level (369.0 ft above MSL), the average velocity approaching the trash racks is approximately 1.4 fps and the average velocity approaching the traveling screens is 1.2 fps.

Fish and debris impinged on the traveling screens at all units are removed during screen rotation by screen wash pumps supplying spray nozzles that wash the fish and debris into screen troughs that empty into a system of troughs built into the screenhouse floor. Fish and debris are carried through the trough system with the assistance of sprays located within the troughs. The trough from each of the two screens for each unit converge between the two screen housings of that unit and pass outside of the screenhouse to a common trough that services all screens and runs the entire length of the river face of the intake structure. Fish and debris in this outside trough are returned to the river through a slide extending to the river surface on the downstream face of the intake.

Heated water is discharged from the plant's condensers through a common 96-inch ID discharge line for Units 1 and 2, and a common 108-inch ID line for Units 3 and 4. These discharge pipes terminate as rectangular submerged jets at an average elevation of 374 feet above MSL into the Mississippi River downstream from the intake structure.

2.3 HISTORICAL DATA

Union Electric Company (UEC) conducted fish impingement monitoring at the Meramec Power Plant during 1974-1975. Studies of the fish community of the Upper Mississippi River also have been conducted in recent years, especially with regard to past or potential impacts from habitat modifications caused by maintenance of navigation and flood control in the river. All of these studies can contribute to an understanding of the health of the fish community in the river and a projection of the levels of fish impingement that might presently be occurring at the power plant. The following is a brief description of the nature of these studies and the data available from them.

2.3.1 Impingement Studies

UEC (now Ameren UE) conducted impingement monitoring at the Meramec Power Plant from July 23, 1974 through July 9, 1975 (EEH 1976, UEC 1977). Impingement occurring during a continuous 24-hour period was monitored twice per month (biweekly), conditions permitting. Fish impinged during the 24-hour period were washed and sluiced into a collection barge stationed at an intake caisson. At the end of the 24-hour period, the fish were removed and identified to species (when possible), counted, and measured for lengths and weights.

Forty-two fish species were identified in the impingement collections of 1974-1975 (Table 2-1). The collections were dominated numerically by a single species, the gizzard shad, which accounted for 93.1 percent of the 42,660 collected fish. When these collections were extrapolated using fish densities in the samples and the ratio of monthly sampled volumes to total monthly cooling water volume, the estimated total number of gizzard shad impinged was 921,362 fish or approximately 95 percent of the total annual impingement (Table 2-2). Gizzard shad impingement was greatest during the winter (i.e., December through February) when 183,000 to 295,000 fish were impinged each month. During the remainder of the year, gizzard shad comprised two-thirds or more of the impingement in all but three months (July 1974, October 1975 and May 1975). The estimated total biomass of gizzard shad lost to impingement during the sampling year was 21,703 kg, or about 70 percent of the total biomass impinged, 30,399 kg (EEH 1976). Approximately 80 percent of the gizzard shad impinged were less than 13 cm in length.

The only other species that numerically constituted more than 1 percent of the impingement collections was the freshwater drum (Tables 2-1 and 2-2). An estimated 24,172 freshwater drum were impinged, weighing a total of 1,116 kg. Most freshwater drum were impinged in the spring and fall, during the months of August-September, November, and March-June (Table 2-2). The eight remaining species comprising the 10 most frequently impinged species, in order of declining abundance, included common carp, shortnose gar, bluegill, white bass, paddlefish, goldeye, flathead catfish, and sauger (Table 2-1). None of these eight species comprised more than 0.5 percent of the impingement total numerically. Larger species, such as the common carp (1,724 kg) and paddlefish (1,142 kg), contributed proportionally more to the estimated total impingement biomass (0.6 percent and 0.4 percent, respectively). Impingement of species other than gizzard shad and freshwater drum declined during late summer and early fall 1974 (August-October), when river flows were lower than during the remainder of the sampling year. Impingement of these species was greatest during March through June (Table 2-2).

In an attempt to reduce winter impingement rates and in consultation with the MoDNR, UEC tested the effects of a reduction in cooling water volume on impingement rates during December 1977 through February 1978 (Bindel 1978). A trial program was proposed based on reducing the number of Meramec's operating circulating water pumps when ambient river water temperatures were less than 70°F (Wooten 1977). The circulating water pump volume pumped during the 3-month trial period was reduced 25 percent compared to the 3-month volume from 1974-1975. Monthly flow reductions for December 1977, January 1978 and February 1978 were 29 percent, 18 percent and 26 percent, respectively, compared to the same months in 1974-1975 (Bindel 1978).

Total impingement during this 3-month trial program correspondingly was reduced 68 percent, with monthly impingement reductions of 36 percent for December, 80 percent for January, and 98 percent for February compared to the same months in 1974-1975. Only 18 species were identified in the impingement collections during the December 1977-February 1978 trial (Table 2-3). Gizzard shad continued to dominate the collections, representing 97 percent of the total 3-month estimated impingement. However, the estimated total impingement of 242,624 gizzard shad reflected a 68 percent reduction from the 772,431 gizzard shad estimated to have been impinged during December 1974 through February 1975.

2.3.2 Nearfield Community Studies

The fish community of the UMR has been the focus for federal and state resource agencies for a long time, particularly because the river has supported viable commercial and recreational fisheries. The fish communities of the UMR historically have been under the jurisdiction of the five states bordering on the river: Missouri, Illinois, Iowa, Wisconsin and Minnesota. However, there were multi-jurisdictional management problems, particularly with regard to commercial and recreational fishing regulations. As a result, the Upper Mississippi River Conservation Survey Committee was formed in 1943. This group has grown from an initial membership of 22 fisheries biologists to more than 200 resource managers and is now known as the Upper Mississippi River Conservation Committee (UMRCC). Its goal is to "promote the preservation and wise utilization of the natural resources of the Upper Mississippi River and to formulate policies, plans and programs for conducting cooperative studies." Initially, regarding the river's fish communities, the organization's objectives were to 1)determine the nature and importance of the river's sport and commercial fisheries, as well as factors influencing fish abundance; and 2) to collect data upon which to base uniform fishing regulations.

The UMRCC serves as a centralized source of data collected by past and current studies on the fisheries resources of the UMR. Since its formation, the UMRCC has maintained a continuous collection of commercial fishery data, which are published annually in the UMRCC Annual Proceedings. In addition to the managed fisheries of the five member states, there have been several specific issues that have received the attention of the UMRCC, including the continuing status of fishery resources, adverse effects of municipal and industrial sewage, impacts from annual drawdowns of navigation pools and commercial navigation traffic, and the importance of off-channel and channel areas to the production of riverine fishes. The UMRCC has published the proceedings of its annual meetings, as well as technical reports, newsletters, and annual progress summaries of current scientific investigations. It conducts or sponsors special workshops and symposia, and maintains a technical library and computerized database of over 3,000 documents relating to the UMR. A particularly useful document that it publishes is the UMRCC Fisheries Compendium, which was released very recently in its third edition (Pitlo and Rasmussen 2004). It contains a summary of the overall current status of the UMR and provides specific information on fish species collected, in particular the important sport and commercial fishes in the UMR and their life histories.

Another source of historical and current information on the fisheries resources of the UMR is the Long Term Resource Monitoring Program (LTRMP). The LTRMP is an element of USACE's Environmental Management Program authorized by the Water Resources Development Act of 1986. The LTRMP originally was designed as a 10-year monitoring program but now has been extended indefinitely by enactment of the Water Resources Act of 1999. The LTRMP is implemented by the US Geological Survey (USGS), with the cooperation of the resource agencies and universities of the five states and the US Fish and Wildlife Service (USFWS), but is the responsibility of the USACE. The long-term goals of the LTRMP are to understand the river system, determine resource trends and impacts, develop management alternatives, manage information, and produce scientific literature and special reports.

The LTRMP monitors the UMR resources within six river reaches, five on the Upper Mississippi River itself and one on the Illinois River. The study reaches most relevant to the Meramec Power Plant are Pool 26 (RM 202-242), which is approximately 40 miles upstream from the plant; and the open river study reach (RM 29-80), which is approximately 80 miles downriver from the plant. While bounding the river reach on which the plant is located, these two study reaches represent somewhat contrasting habitats. Pool 26 is in the most downstream portion of the impounded UMR at the confluence of the Illinois River and above the confluence of the Missouri River, and the open river study reach represents the unimpounded MMR. In order to make all LTRMP monitoring data comparable both spatially and temporally, the LTRMP since 1993 uses a stratified random sampling design (Gutreuter et al. 1995) and standardized sampling methods and gear, including day and night electrofishing, tandem fyke net, tandem mini-fyke nets, gill nets, hoop nets, seine, anchored trammel nets, and bottom trawl. In 2002, the seine, tandem fyke net, tandem mini fyke net, and night electrofishing were eliminated as sampling gear (Ickes and Burkhart 2002).

The LTRMP has surveyed the river annually since 1987 and produces annual reports of its findings. It also publishes an ecological status and trend report at 5-year intervals, the most recent being published for 1990-1994 (USGS 1999). This report includes status summaries for multiple river resources, including fishes and sediment and water quality. Annual status reports containing fisheries data by study reach (Burkhardt et al. 2001) and summaries of fiscal year findings (Hegland et al. 2004) are also published. The Upper Midwest Environmental Sciences Center, which produces the LTRMP documents, provides a graphical fish database browser for the LTRMP data on its website (http://www.umesc.usgs.gov/data_library/fisheries/graphical/fish_front.html) which will plot trend data for a specified range of years by species, gear, study reach, and river stratum.

Lastly, some information on the status and issues involving the fish communities of the UMR is available in the Draft Integrated Feasibility Report and Programmatic Environmental Impact Statement for the Upper Mississippi River-Illinois Waterway System Navigation Feasibility Study released on April 29, 2004 for public review and comment (USACE 2004). This study is the USACE's most recent effort to formulate a plan for making modifications and operational changes to improve navigation in the river, while meeting the needs of the river ecosystem and ensuring environmental sustainability. The proposed plan incorporates an adaptive management approach and would provide funding and a long-term framework for ecosystem restoration and navigational improvements.

2.3.3 Sufficiency of Existing Information for IM Characterization Study

As described in Section 1.2, the IM Characterization Study requires biological data on the following:

1. Identification of fish and shellfish life stages and species in the vicinity of the CWIS and susceptible to impingement;
2. Their abundance and spatial/temporal distribution, sufficient to characterize the annual, seasonal and diel variations in impingement mortality; and
3. Documentation of current impingement mortality of these species and life stages.

As demonstrated above, there is an extensive amount of information available on the fish community of the Mississippi River in the vicinity of the Meramec Power Plant that might satisfy the first two requirements. However, there are no current data on impingement at Meramec, since the only impingement studies were conducted 25 to 30 years ago.

In terms of the river's fish community and its relationship to impingement at Meramec (the first two items above), sustained trends in annual abundance could cause some species or life stages to become more or less abundant in the vicinity of the Meramec's CWIS, and thus more or less susceptible to impingement. It is also possible that recently introduced species (Rasmussen et. al 2004), such as the grass carp, bighead carp, silver carp, and zebra mussel are affecting impingement totals or displacing the species that were impinged in the past. The data routinely collected for the UMR by the LTRMP provide information on trends of increasing or decreasing abundance of species on a regional (study reach) and river-wide basis since 1987. Recent trends observed in the LTRMP database for individual fish species of importance to the Meramec CWIS are discussed in Section 3.3. While these data were not collected in the immediate vicinity of the Meramec intake, the open river study reach of the LTRMP might best represent the habitat present near the Meramec intake, even though it is over 80 miles downriver from the plant.

Improved water quality might affect the abundance and composition of the fish community in the immediate vicinity of the plant's intake. Due to extensive improvements in residential and industrial wasterwater treatment, water quality in the UMR has improved since the 1970's (Soballe and Weiner 1998), when impingement monitoring at the plant was conducted. The St. Louis Metropolitan Sanitary District opened the first of two major treatment plants in 1970, and the last large primary treatment facility was upgraded to secondary treatment in 1993 (Soballe and Weiner 1998). Also, Meramec is located approximately 35 miles downriver from the confluence of the Missouri River. At this confluence, inflow from the Missouri River increases the flow of the UMR by about two-thirds and carries a sediment load that is more than twice that of the UMR (Soballe and Weiner 1998). The effect of inflow of the Missouri River on the fish community in the vicinity of the Meramec intake is uncertain, but it could change based on annual variation in the Missouri River flow.

The third item listed above as information required for the IM Characterization Study, i.e., documentation of current impingement mortality, would not be satisfied by using available data. Impingement monitoring has not been conducted in over 25 years. The one-year impingement monitoring program conducted during July 1974-July 1975 would not reflect the current intake traveling screen configuration (conventional traveling screens used in the 1970's recently were replaced with dual-flow traveling screens). Therefore, an impingement monitoring program is proposed to document the annual, seasonal and daily impingement rates that reflect the current status of the fish community, and the current intake configuration and operation.

The remaining sections of this sampling plan are devoted to describing the fish community for the purpose of a preliminary selection of representative species, and to outlining a recommended sampling scope for monitoring impingement at Meramec.

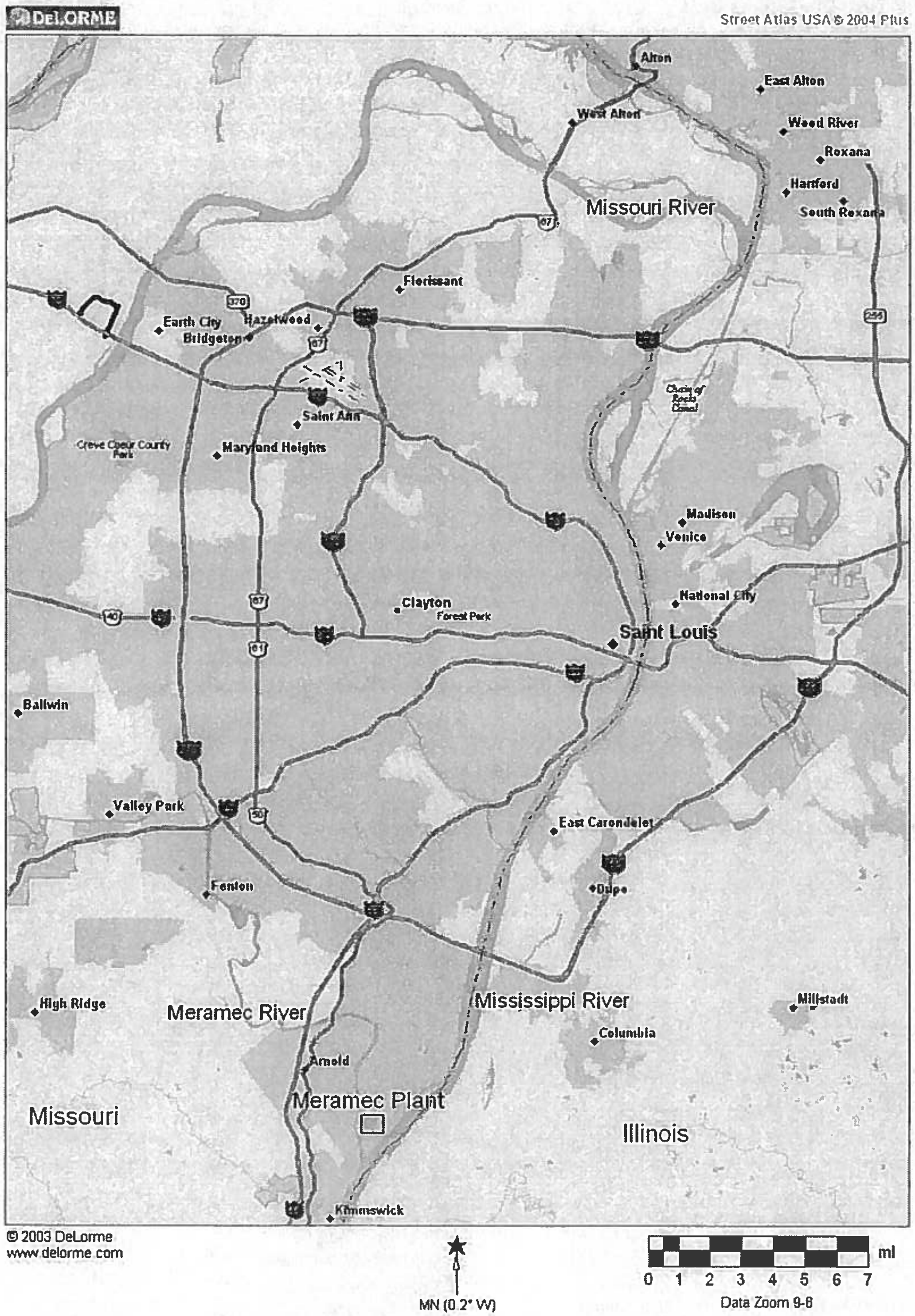


Figure 2-1 Location of the Meramec Power Plant

Table 2-1 Fish Species Collected in Impingement Monitoring at the Meramec Power Plant, July 23, 1974 through July 9, 1975

Family	Common Name	Scientific Name	Number Collected	Relative Abund. (%)
Lampreys-Petromyzontidae	Chestnut lamprey	*Ichthyomyzon castaneus*	2	<0.1
Sturgeons-Acipenseridae	Shovelnose sturgeon	*Scaphirhynchus platorynchus*	16	<0.1
Paddlefishes-Polyodontidae	Paddlefish	*Polyodon spathula*	85	**0.2**
Gars-Lepidosteidae	Longnose gar	*Lepisosteus osseus*	6	<0.1
	Shortnose gar	*Lepisosteus platostomus*	161	**0.4**
	Gar	*Lepisosteus*	76	0.2
Bowfins-Amiidae	Bowfin	*Amia calva*	3	<0.1
Mooneyes-Hiodontidae	Goldeye	*Hiodon alosoides*	77	**0.2**
	Mooneye	*Hiodon tergisus*	35	0.1
Freshwater eels-Anguillidae	American eel	*Anguilla rostrata*	1	<0.1
Herrings-Clupeidae	Gizzard shad	*Dorosoma cepedianum*	39,706	**93.1**
Carps & Minnows-Cyprinidae	Sicklefin chub	*Macrhrybopsis meeki*	7	<0.1
	Silver chub	*Macrhrybopsis storeriana*	59	0.1
	Common carp	*Cyprinus carpio*	221	**0.5**
	Golden shiner	*Notemigonus crysoleucas*	1	<0.1
	Flathead chub	*Platygobio gracilis*	3	<0.1
	Minnow	Cyprinidae	1	<0.1
Suckers-Catostomidae	River carpsucker	*Carpoides carpio*	35	0.1
	Quillback	*Carpoides cyprinus*	5	<0.1
	Carpsucker	*Carpoides sp.*	6	<0.1
	Sucker	*Catostomidae*	17	<0.1
	White sucker	*Catostomus commersoni*	2	<0.1
	Northern hogsucker	*Hypentelium nigricans*	3	<0.1
	Smallmouth buffalo	*Ictiobus bubalus*	31	0.1
	Bigmouth buffalo	*Ictiobus cyprinellus*	51	0.1
	Black buffalo	*Ictiobus niger*	3	<0.1
	Buffalo	*Ictiobus sp.*	1	<0.1
	Golden redhorse	*Moxostoma erythrurum*	2	<0.1
	Shorthead redhorse	*Moxostoma macrolepidotum*	11	<0.1
Bullhead catfishes-Ictaluridae	Blue catfish	*Ictalurus furcatus*	24	0.1
	Black bullhead	*Ameiurus melas*	26	0.1
	Channel catfish	*Ictalurus punctatus*	24	0.1
	Catfish	*Ictalurus sp.*	6	<0.1
	Bullhead	*Ameiurus sp.*	2	<0.1
	Stonecat	*Noturus flavus*	8	<0.1
	Madtom	*Noturus sp.*	1	<0.1
	Flathead catfish	*Pylodictis olivaris*	68	**0.2**
Cods-Gadidae	Burbot	*Lota lota*	2	<0.1
Silversides-Atherinidae	Brook silverside	*Labidesthes sicculus*	1	<0.1
Temp. Basses-Percichthydiae	White bass	*Morone chrysops*	98	**0.2**
Sunfishes-Centrarchidae	Sunfish	*Centrarchidae*	14	<0.1
	Green sunfish	*Lepomis cyanellus*	1	<0.1
	Orangespotted sunfish	*Lepomis humilis*	2	<0.1
	Bluegill	*Lepomis macrochirus*	115	**0.3**
	Largemouth bass	*Micropterus salmoides*	5	<0.1
	White crappie	*Pomoxis annularis*	21	<0.1
	Black crappie	*Pomoxis nigromaculatus*	32	0.1
	Crappie	*Pomoxis sp.*	5	<0.1
Perches-Percidae	River darter	*Percina shumardi*	1	<0.1
	Sauger	*Stizostedion canadense*	67	**0.2**
	Walleye	*Stizostedion vitreum*	5	<0.1
Drums-Scianidae	Freshwater drum	*Aplodinotus grunniens*	1,505	**3.5**
		TOTAL	42,660	

Table 2-2 Estimated Monthly Impingement Totals for Meramec Power Plant, 1974-1975

	Gizzard Shad		Freshwater Drum		Other Species		All Species	
Month	Numbers	% of Total	Numbers	% of Total	Numbers	% of Total	Numbers	% of Total
16-31 July-74	882	28.5	262	8.5	1,953	63.1	3,097	100
August-74	5,271	65.3	2,401	29.7	403	5.0	8,075	100
September-74	2,964	62.6	1,464	30.9	304	6.4	4,732	100
October-74	500	41.6	369	30.7	333	27.7	1,202	100
November-74	69,887	93.4	3,159	4.2	1,771	2.4	74,817	100
December-74	287,159	99.5	257	0.1	1,090	0.4	288,506	100
January-75[1]	295,429	99.1	140	0.0	2,504	0.8	298,073	100
February-75	183,384	98.9	116	0.1	1,920	1.0	185,420	100
March-75	28,914	85.6	1,189	3.5	3,674	10.9	33,777	100
April-75	22,916	74.6	4,593	14.9	3,215	10.5	30,724	100
May-75	7,168	33.9	7,612	36.0	6,383	30.2	21,163	100
June-75	14,436	73.9	2,049	10.5	3,058	15.6	19,543	100
1-5 July-75	2,452	63.8	561	14.6	833	21.7	3,846	100
TOTAL	921,362	94.7	24,172	2.5	27,441	2.8	972,975	100

[1] Note: January totals are based only on a single 24-hour sample

Table 2-3 Estimated Monthly Impingement at Meramec Power Plant, December 1977 through February 1978

Species	December	January	February	3-Month Total
Bigmouth buffalo	0	29	0	29
Black buffalo	27	0	0	27
Black bullhead	67	0	22	89
Blue catfish	213	374	183	770
Channel catfish	27	79	213	318
Common carp	27	0	37	63
Flathead catfish	0	57	286	343
Freshwater drum	719	2,593	623	3,935
Gizzard shad	182,706	57,220	2,698	242,624
Goldeye	27	29	213	268
Mooneye	0	0	44	44
Paddlefish	27	0	0	27
Quillback	27	29	44	99
River carpsucker	27	0	37	63
Shortnose gar	0	43	37	80
Sicklefin chub	0	0	15	15
Smallmouth buffalo	0	108	0	108
White bass	93	108	15	216
TOTAL	183,985	60,668	4,465	249,118

3. FISH AND SHELLFISH COMMUNITY

This section describes the aquatic habitat and the fish community in the vicinity of the Meramec Power Plant. A preliminary list of Representative Species for detailed study is then recommended on the basis of their abundance in previous impingement collections or importance due to their economic value, ecosystem role, or protected status.

3.1 AQUATIC HABITAT

The aquatic habitat in the MMR, and specifically in the vicinity of the Meramec CWIS, is largely the result of man's attempts to control the flow of the Mississippi River for purposes of commercial navigation (now primarily barges and towboats) and flood control. Navigation channel modifications began as early as 1866 when Congress authorized the USACE to develop a reliable 3-foot deep channel for navigation during low water periods (Rasmussen and Pitlo 2004a). As navigation demands increased, the depth of this channel was increased by subsequent congressional authorizations in 1878, 1907, and 1927 to 4.5 feet, 6 feet, and 9 feet, respectively. Channel modifications first took the form of rock and brush wing dikes used to consolidate the river flow to a single channel. Side channels, backwater areas, and the main channel border (zone between the navigation channel and the riverbank or islands) were blocked by wooden pile dikes and willow mats. Over time all of these structures were fortified or replaced by stronger and higher stone structures. Wing dikes initially were designed to produce a minimum channel width of 200 feet during low water, which in 1927 was increased to 300 feet. Wing dikes have decreased the average width of the MMR from 5300 feet in 1888 to 3,200 feet in 1968 (Rasmussen and Pitlo 2004a). There are now over 800 wing dikes in the 183.5-mile-long MMR. In addition to the channel structures, nearly continuous levees have been constructed in the floodplain along the length of the MMR to prevent flooding of agricultural areas and land developments.

The overall effect of man's modifications of the river channel and floodplain has been a decrease in habitat diversity. The total surface area of the MMR has been reduced. In many places there has been a degradation of the channel bed from scouring, leaving side channels and the original river channel area perched above and isolated from the main channel (Rasmussen and Pitlo 2004a). With the dikes, levees and floodwalls narrowing the channel and isolating it from much of the floodplain, more rapid changes in the water surface elevation have resulted and flood heights have increased, as observed in the St. Louis area (Rasmussen and Pitlo 2004a). Fine sediments are deposited behind the wind dikes, filling in backwaters and side channels. Sand is deposited either in shoals in the main channel or between the wing dikes along the main channel border, usually requiring frequent dredging and sometimes resulting in dredge spoil disposal in the side channel and backwater areas. Ultimately, the ecologically rich side channels and backwaters are destroyed. Research is showing that these areas are very productive and may serve as important resting, spawning, rearing and overwintering areas for many species. Loss of access to the floodplain may have consequences related to nutrient cycling and loss of spawning habitat for certain species.

The navigation channel closely approaches the west bank, where the Meramec intake is located. At its greatest depth, the riverbed elevation here is 346 feet above MSL, while the surface elevation at median flow is 380.6 feet (UEC 1977). The width of the river is approximately 2,300 feet at median daily flow and 1,600 feet at minimum daily flow. Diversion of the main channel toward the western shore may be the result of a series of wing dikes along the eastern shore opposite the plant, which leaves a relatively narrow main channel border along the western bank and a wider main channel border between the wing dikes along the eastern bank (Figure 3-1). The substrate in the main channel and the main channel border is primarily sand and silt over sand, with occasional gravel patches. Along the western river bank where the Meramec intake structure is located, there is a submerged rock ledge, which was blasted and excavated for the construction of the intake structure's foundation. No rooted aquatic vegetation is present within the river.

Water quality in the vicinity of the plant is greatly influenced by inflow from the Missouri River and the industrialized waterfront of St. Louis (UEC 1977). Water quality has improved in recent years, particularly with regard to dissolved oxygen (DO) concentration (Section 2.3.4). The median DO concentration according to LTRMP data from 1988 to 1993 was 80 percent of saturation (Soballe and Weiner 1998). Elevated concentrations of ammonia have been observed near St. Louis. Turbidity and suspended solids are especially high because of the inflow of the Missouri River, whose basin contains highly erodible soils and is intensively farmed. Agriculture is also the major source for pesticides in the river and its sediments. Other contaminants occur, such as the common surfactant LAS (linear alkylbenzene sulfonate), heavy metals (e.g., cadmium), and coprostanol, an organic compound present in fecal matter and associated with sewage contamination from municipal effluents and agricultural feedlot runoff (Soballe and Weiner 1998).

3.2 COMMUNITY COMPOSITION

There are several accounts of the number of fish species found in the UMR, but all of the accounts have one thing in common—the fish community is extraordinarily diverse. At least 260 freshwater species have been reported for the Upper Mississippi River Basin (Gutreuter and Theiling 2004), and 193 truly freshwater species in 27 families have been reported for the Mississippi River (Schramm, in press). Of these 193 species, from 112 to 122 species occur in the MMR. The presence of such a great number of species likely is due to the physical complexity of the river system and the diversity of available habitats.

In comparison, a total of 42 fish species were identified in the impingement collections at Meramec during the 1970's (Section 2.3.1, Table 2-1), or approximately one-third of the resident species in the MMR. The impinged species appeared to come from several river habitats and ranged from being relatively abundant members of the fish community to relatively uncommon or rare species. Of the ten species most frequently impinged during 1974-1975, seven are considered to be abundant or common in the unimpounded river, including the gizzard shad, freshwater drum, common carp, shortnose gar, bluegill, white bass, and flathead catfish. The remaining three species (paddlefish, goldeye, and sauger) currently are viewed as species that are occasionally collected, i.e., not generally distributed but sometimes having local concentrations (Schramm, in press). Sixteen of the species impinged at Meramec could be classified as being dependent on backwater habitat and five could be considered as strictly riverine species, i.e., occupying the main channel or main channel border (Schramm, in press). The remaining species would be fairly evenly distributed among the available habitat types.

3.2.1 Protected Species

There are several fish species in the MMR or the open reach of the Mississippi River (Schramm, in press) that are currently listed as species of concern by the state of Missouri (http://mdc.mo.gov/cgi-bin/echecklist/search.cgi?TYPE=FISH). There is only one federally listed species, the pallid sturgeon. The pallid sturgeon was not collected during the impingement monitoring programs at Meramec. State-listed species that were impinged include the flathead chub, sicklefin chub, silver chub, paddlefish, river darter, and mooneye (Section 2.3.1, Table 2-1). Of this group, only the flathead chub is listed by the state as endangered, with a state rank of S1, i.e., “critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state.” The flathead chub's global ranking is G5, signifying that it is “demonstrably widespread, abundant, and secure globally, though it may be quite rare in parts of its range, especially at the periphery.” A status assessment is currently underway by the USFWS regarding a possible federal listing of the species. The flathead chub is a species adapted to turbid waters where the current is swift and only occurs in the Mississippi River below the confluence of the Missouri River. Possible reasons for its decline are nonpoint source pollution, mainstem impoundments impacting flow regimes, and degradation of riparian areas.

The other five state species of concern that were impinged are listed with the state rank of S3 or “rare and uncommon in the state” and a global ranking of G3 (sicklefin chub), G4 (paddlefish) or G5 (silver chub, river darter, and mooneye)[2]. Several environmental organizations petitioned the USFWS to list the sicklefin chub, along with the sturgeon chub, as endangered species. In April 2001, the USFWS announced its finding that these species do not warrant listing as being endangered or threatened, stating that “while the historic range of the sicklefin and sturgeon chub has been reduced, we have concluded that stable, self-sustaining populations remain widely distributed throughout their range.”

Besides the pallid sturgeon, there are many state-listed fish species not found in Meramec impingement collections. Some of these species have been reported as occurring in the Missouri waters of the Mississippi River, lower Missouri River, or Meramec River within the past 30-50 years (Pflieger 1997, Pitlo and Rasmussen 2004; Schramm, in press) and thus still may occur in the vicinity of the Meramec intake on occasion. These species include the lake sturgeon (*Acipenser fulvescens*), Alabama shad (*Alosa alabamae*), central mudminnow (*Umbra limi*), western silvery minnow (*Hypognathus argyritis*), Mississippi silvery minnow (*H. nuchalis*), plains minnow (*H. placitus*), sturgeon chub (*Macrohybopsis gelida*), ghost shiner (*Notropis buchanani*), highfin carpsucker (*Carpoides velifer*), blue sucker (*Cycleptus elongatus*), brown bullhead (*Ameiurus melas*), starhead topminnow (*Fundulus dispar*), flier (*Centrarchus macropterus*), and western sand darter (*Ammocrypta clara*). Of these species, the lake sturgeon, pallid sturgeon, and central mudminnow are listed as state endangered species. It is conceivable that some of these species could appear in future impingement sampling at Meramec.

3.2.2 Exotic Species Introductions

There are several non-indigenous fish species in the MMR that have become important constituents of the fish community, including the commercially exploited common carp. However, none has been as potentially destructive as the recently introduced asian carp species, including the grass carp or white amur (*Ctenopharyngodon idella*), bighead carp (*Hypophthalmichthys nobilis*) and silver carp (*Hypophthalmichthys molitrix*). These three

[2] G3 means that it is “either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range...or because of other factors making it vulnerable to extinction throughout its range.” G4 means “widespread, abundant, and apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.” G5 means “demonstrably widespread abundant, and secure globally, though it may be quite rare in parts of its range, especially at the periphery.”

species are becoming well established in the UMR system and threaten to disrupt the trophic dynamics of the UMR ecosystem. The bighead carp and silver carp also have become a nuisance, or even a hazard, to the commercial and recreational fisheries of the river due to their large size and propensity to either interfere with the retrieval of commercial fishing gear, or in the case of the silver carp, to jump several feet out of the water when frightened by boat motors, occasionally striking boaters in the process. All have been introduced to the ecosystem either intentionally through stocking interconnecting waterways or accidentally through escapement from captivity.

The grass carp is an herbivore imported from eastern Asia and intentionally stocked to control aquatic macrophyte growth in Arkansas and elsewhere (Rasmussen et al. 2004). Grass carp exhibit rapid growth and can attain lengths up to 63 inches and weights up to 81 pounds. Grass carp even comprised a portion, albeit minor (<1 percent), of the annual UMR commercial fishery harvest between 1976 and 1998 (Rasmussen et al. 2004). Potential negative effects on the UMR fish community are interspecific food competition with invertebrates and native fishes, interference with reproduction of other species, decreased refugia or modification of preferred habitat for other fishes, and introduction of nonnative parasites or diseases (Rasmussen et al. 2004).

Bighead carp is a large species native to large rivers in eastern China. It began to appear in the Mississippi River in the early 1980's. It first appeared in the UMR commercial fishery in 1993 and, together with the silver carp, it contributed a total harvest of 77,230 pounds to the fishery in 1998 (Rasmussen et al. 2004). It reportedly has filled commercial nets to the point that they could not be retrieved so that fishing sites had to be abandoned. The bighead carp has a laterally compressed body and very large head, and can reach lengths of 40 inches and weights of 75-90 pounds. It is adapted to straining planktonic organisms for food, and thus would compete with indigenous planktivores like gizzard shad, paddlefish and bigmouth buffalo, as well as larval fishes and mussels.

Silver carp also is a planktivorous species originating from large rivers in eastern Asia. Its history in the U.S. is largely linked to the bighead carp and its potential impacts on the UMR ecosystem are the same. However, it is a more efficient plankton strainer because its gill rakers are fused into sponge-like porous plates, which allow it to strain small, bacteria-sized particles (Rasmussen et al. 2004). The silver carp is rapidly increasing in abundance in the UMR, where it can reproduce in off-channel and backwater areas.

Although these three asian carp species will grow rapidly and thus become less vulnerable to impingement at Meramec, an occasional adult specimen could become impinged as well as smaller juveniles. Their presence in the long term could affect the species composition and distribution of the fish community.

3.2.3 Current Fish Community Status and Trends

Initial concerns with the status and trends of the fish community were related to the commercial and recreational fisheries of the river. The National Marine Fisheries Service kept commercial fishery statistics on the Mississippi River until 1977 and observed a general downward trend in the catch up until that time (Schramm, in press). The UMRCC began keeping the commercial fishery statistics for the UMR north of the Ohio River confluence (thus including the MMR) in 1945 and has continued to maintain the database. Common carp, buffalo species, catfish species and freshwater drum historically have made up 95 percent of the total catch and 99 percent of the value of the UMR commercial fishery (Rasmussen and Pitlo 2004b). These statistics could be altered dramatically with the introduction of the asian carp species, particularly if commercial markets are developed. Commercial catch of the common carp remained relatively high from 1958 through 1975, but has experienced a decline since then, while the harvest of buffalo, catfish and freshwater drum has nearly doubled during that time interval (Schramm, in press). A quantitative evaluation of the recreational fishery in the MMR is not available.

The LTRMP (discussed in Section 2.3.3) provides annual catch-per-unit-effort (relative abundance or CPUE) statistics for each species, along with other population and community metrics including proportional stock density (size structure), frequency of occurrence in samples, community composition, and species richness (total number of species). Species richness both in Pool 26 upstream from Meramec and the Open River Reach at Cape Girardeau downstream from Meramec shows relative stability during from 1993 through 2003. The number of species caught in these two reaches ranged annually from 58 to 70, reflecting the chance occurrence of rare or uncommon species in the samples (Figures 3-2 and 3-3). Trends in CPUE of individual species are discussed for selected species in Section 3.3.

There is concern that there may be a decline in species dependent upon backwater habitats if these areas continue to diminish because of siltation and the effects of river flow manipulation for navigation (Schramm, in press). The LTRMP is designed to detect whether these community changes occur though time.

3.3 REPRESENTATIVE SPECIES

Representative Species (RS) typically would be those most frequently observed in impingement collections, or most important because of their economic value, value to the ecosystem, or protected status. In addition to being the target species for evaluating compliance with impingement mortality reductions, RS could be used to estimate the economic losses of fish impingement for a cost-benefit analysis under the EPA site-specific compliance alternative #5 or for scaling restoration efforts and verifying the success of restoration alternatives. It would be important to collect length, weight, and age data from RS during the impingement monitoring program in order to estimate individual growth rates and biomass production for species used in the cost-benefit and restoration analyses. Such detailed analyses would not be possible or practical for all species impinged. Therefore, RS would serve as surrogates for other species of less critical importance or abundance.

Choosing Represent Species (RS) for more detailed analysis in impingement sampling at Meramec is especially difficult because the fish community, as well as the list of impinged species, is so diverse and there are many species that may be considered prominent because of their abundance or ecological or economic value. On the other hand, impingement at Meramec in the past has been totally dominated by a single species, the gizzard shad. This dominance of impingement numbers and biomass, as well as its ecological role in the ecosystem, makes the selection of gizzard shad automatic. Of the ten most frequently impinged species, seven species in addition to the gizzard shad may be good indicators of the potential impacts of impingement on the commercial and recreational fisheries of the river and the important families to which they belong: cyprinids (carp and minnows), drum, catfish, centrarchids (sunfish and bass), percids (perches), temperate basses, and the paddlefish (a species of concern).

This section lists the eight fish species recommended for detailed study. The rationale for choosing each species is presented, along with a brief summary of its life history and distribution in the area and recent population trends, if any. As impingement monitoring progresses, this list could be modified to reflect current conditions.

3.3.1 Gizzard Shad

The gizzard shad is one of the most abundant fish species in Missouri, where it occurs in every stream system but is most abundant in the Mississippi and Missouri Rivers (Pflieger 1997). It is so abundant in some locations that it is sometimes considered a nuisance species, possibly competing with other species for food and space. It is a very important prey species in the UMR, providing greater than 50 percent of the food items for species such as largemouth bass, crappie and sauger (Gutreuter and Theiling 1998). Its productivity is linked to its role in the trophic structure of the community, since it feeds on both plants (phytoplankton and periphyton) and animals and is planktivorous. It was by far the most frequently impinged species at Meramec in the 1974-1975 monitoring program, with 39,706 specimens being collected (Section 2.3.1, Table 2-1). The projected total annual impingement of gizzard shad from July 1974 to July 1975 was approximately 921,000 fish (UEC 1977).

Almost all (94 percent) of the impingement occurred during the winter and early spring months (November-April), and 83 percent occurred during the period from December through February. This spike in impingement likely was related to a weakened condition of the gizzard shad, a species known to be subject to natural winter die-offs when water temperatures decline below 11 °C and young gizzard shad cease feeding (White et al. 1986). As a result, young gizzard shad must rely on the metabolism of lipid reserves for survival, but prolonged cold temperatures, particularly below 8 °C, can result in liver and brain dysfunction and catabolism of body tissues, leading to disorientation and/or death.

Gizzard shad spawn in early April and May in shallow water in relatively protected areas (Pflieger 1997). The eggs are adhesive and attach to the bottom. Young gizzard shad grow very quickly, reaching 6 to 7 inches by the end of their first year (Benson 1970). This rapid growth rate limits the period when they are effectively preyed upon to approximately their first six months of life, since by September they become too large for all but the largest predators. Gizzard shad mature in their second or third year of life at ages I-II (Pflieger 1997).

Gizzard shad are more abundant in the lower reaches of the UMR, such as the open river (unimpounded) reach, than in the upper reaches (Gutreuter and Theiling 1998). As young they are abundant along the shore, e.g., in the Missouri River, in late May and June (Pflieger 1997). As adults, they are most frequently found in quiet waters, such as backwaters and pools, where they form large moving schools, often near or at the surface. They feed on algae, plankton and insects by filter-feeding through their gill rakers.

Daytime electrofishing data from the LTRMP for the past 11 years (1993-2003) indicate that their annual abundance can be variable. Peaks in CPUE occurred in Pool 26 and the Open River Study Reach in 1993, 1995, 1998, and 2002 (Figures 3-4 and 3-5). No sustained trend in abundance is evident.

3.3.2 Freshwater Drum

Like the gizzard shad, in the state of Missouri the freshwater drum is most abundant in the Mississippi and Missouri Rivers (Pflieger 1997). It is an important commercial and recreational fish species in the UMR, being a major component of the harvest of both fisheries. During 1993 to 1996, it ranked first in the summer creel survey conducted on Pools 11 and 13 and has been ranked about fourth in the commercial harvest of the UMR (LaJeone et al. 2004). It was the second-most frequently impinged species during the 1974-1975 monitoring program at Meramec, with 1,505 specimens collected during sampling (Section 2.3.1, Table 2-1) and a projected total annual impingement of approximately 27,400 fish (UEC 1977). Almost half of these fish were young-of-the-year and almost all of them (97 percent) were immature fish.

The freshwater drum spawns in late April and May. Although spawning has not been directly observed, it apparently occurs in shallow, open water, possibly in tributaries to the river (LaJeone et al. 2004). Eggs and larvae are buoyant and drift with the river flow. Adult freshwater drum feed by grubbing along the bottom and consuming mollusks, insects, fish and crayfish. They apparently will feed on zebra mussels, the pest species recently introduced to the river system. Freshwater drum are slow growing and long-lived. They can reach up to 20 inches in length and 10 pounds in the UMR, but most are 1 to 3 pounds in size (LaJeone et al. 2004). Males will mature at ages III-IV and lengths of 11 to 14 inches, while females mature at ages V-VI and 13-15 inches.

The UMR provides excellent habitat for freshwater drum, where they are abundant living on or near the bottom in all pools. It is relatively tolerant of turbidity. In summer months it can be found in nearly all river areas, including tailwaters, but in the winter at water temperatures less than 50°F, it will avoid strong currents and seek deeper side channels and backwaters (LaJeone et al. 2004)

The buoyancy of its eggs and larvae makes this species more vulnerable to entrainment into water intakes and boat propeller wash. The young are also sensitive to near-freezing temperatures in the main channel and side channels during winter, which can lead to overwinter mortality during severe or prolonged periods of cold temperatures if thermal refugia are not available (LaJeone et al. 2004). The LTRMP electrofishing CPUE data from 1993 through 2003 for Pool 26 and the Open River Reach show fairly constant numbers of freshwater drum annually, with the possible exception of a peak in abundance in 1993 (Figures 3-6 and 3-7).

3.3.3 Common Carp

The common carp is not an indigenous species. It was introduced into this country from Europe and Asia and was first detected in the Mississippi River in 1883 (Gutreuter and Theiling 1998). It is a dominant species in the commercial fishery of the UMR. In Missouri, common carp have contributed more to the commercial harvest than any other species in 37 of the 47 years of record (Pflieger 1997). The common carp is not actively fished by the recreational fishery. Young carp are preyed upon heavily by large predatory fish species in the UMR. The common carp was the third-most frequently impinged species found during the 1974-1975 monitoring program at Meramec, with 221 specimens collected during sampling (Section 2.3.1). Seventy-five percent of the 221 fish were collected on a single date, May 30, 1975 (UEC 1977).

The common carp spawns in shallow water from late March to June in the UMR (Hrabick and Petersen 2004). Spawning in the MMR, the southern most portion of the UMR, probably occurs nearer the start of this time interval. Heavy rains may frequently trigger spawning activity, when carp could move onto flooded portions of the off-channel areas and floodplain to reproduce. They randomly broadcast their demersal, adhesive eggs onto firm substrate. Larval common carp transform to the juvenile life stage at about 0.2-0.3 inches in length and continue to grow rapidly. They begin to mature by age II (12-18 inches and 0.3-0.6 pounds) and usually are fully mature by age V. In the UMR they can reach up to 53 pounds in weight (Hrabick and Petersen 2004).

Larvae can be found in the UMR from late April through June in littoral areas during daylight. At night, they disperse more evenly among habitats and can become more vulnerable to capture and the effects of barge traffic (Hrabick and Petersen 2004). Fry and juveniles tend to concentrate in shallow, weedy backwater areas but will occur in a variety of habitats. Adult common carp are considered to be habitat generalists, but are often found aggregating in deep pools around cover and may overwinter in at these depths. Common carp adults usually are not highly migratory. They are omnivorous bottom feeders, often being accused of competing with native species, such as the native buffalo fishes, and causing negative impacts by consuming fish eggs, uprooting vegetation and increasing water column turbidity by their winnowing of the bottom for food. If this is true, their effects might be less in the open reach of the river, such as the MMR, then in the pooled portion of the UMR to the north, where there is more vegetation. The catch rate in the open river reach also appears to be lower than the rest of the UMR, particularly Pool 26 immediately to the north of Meramec and the LaGrange Pool of the Illinois River (Gutreuter and Theiling 1998, Hrabick and Petersen 2004).

Commercial harvest records have indicated a decline in abundance of common carp since the 1970's. Daytime electrofishing during LTRMP surveys from 1993 through 2003 indicate annual fluctuations in abundance, with a gradual decline in Pool 26 since 1997 (Figure 3-8), and a possible increasing trend since 1999 in the Open River Study Reach (Figure 3-9). If a lasting trend in their abundance were to emerge, it might be attributed to the effects of increasing water quality through land use reform and possibly reversal of habitat degradation (Hrabick and Petersen 2004). Their previous abundance may have been due to their tolerance for a wide range of conditions, including warm temperatures (106°F limit) and low dissolved oxygen concentration (<3 ppm).

3.3.4 Bluegill

The bluegill is a panfish species that is highly prized by anglers and is also ecologically important as a forage species, particularly in the impounded portion of the UMR. It serves as prey to many game species such as the flathead catfish and largemouth bass, and as a host for 14 species of native Unionid mussels (Cornish and Welke 2004). It was the fifth-most frequently impinged fish species during the 1974-1975 monitoring program at Meramec, with 115 specimens being collected during sampling (Section 2.3.1, Table 2-1). Three samples (November, April and May) accounted for 99 of the 115 fish collected (UEC 1977).

Bluegills spawn from late May to August in the UMR, with peak spawning in June. In Missouri waters, spawning probably occurs earlier during this period than in more northern portions of the UMR. Bluegills are colonial breeders in the sense that spawning fish build nests that are usually in close proximity to each other. Males construct nests that are about 1 foot in diameter in shallow water (depths of 1 to 3 feet). The eggs from several females can be fertilized and deposited in the nest, which is then defended by the male until the eggs have hatched. Because the nests are located in shallow depths, water level fluctuations can severely impact successful reproduction, as nests can be stranded by a lowering water level or disrupted by severe wave action (Gutreuter and Theiling 1998, Cornish and Welke 2004). Bluegills mature by ages II-III and can reach a length of 7 inches by age IV. Maximum sizes in the UMR are about 12 inches and 2 pounds (Cornish and Welke 2004).

Bluegills occur in all river habitats but are most frequently found in backwater habitats such as shallow river lakes and sloughs containing vegetation and woody debris (Gutreuter and Theiling 1998, Cornish and Welke 2004). They are widely distributed and abundant in the UMR but may be limited locally by the amount of backwater habitat. Recent LTRMP data (1993-2003) indicate that their densities, measured by daytime electrofishing CPUE, are lower in the unimpounded, Open River Reach (i.e., Cape Girardeau, MO), which would have less or more unstable backwater habitat, than in the impounded reaches of the UMR. Bluegills are not particularly migratory but do exhibit local (e.g., up to 1.5-7 miles) or seasonal movements.

The future abundance of the species may be affected by the continual sedimentation and filling of backwater areas and by water level fluctuations, particularly during the winter. Overwinter survival is dependent on a sufficient dissolved oxygen concentration and sufficient water temperature (e.g., 34.7°F) and water depths (e.g., 3 feet) to allow movements beneath thick ice and snow cover (Cornish and Welke 2004). A decline in bluegill abundance may be avoided to some degree through planned restoration of backwater areas. LTRMP data from 1993 through 2003 show peaks in abundance in Pool 26 and the Open River Reach in 1993-4 and 2001 (Figures 3-10 and 3-11).

3.3.5 White Bass

The white bass is a relatively abundant species in the UMR and is rated by anglers as a fair to good food fish and an excellent sport fish (Sallee et al. 2004). In angler surveys conducted between 1962 and 1973, white bass was ranked from fourth to sixth in the recreational catch. It was the sixth-most frequently impinged fish species during the 1974-1975 monitoring program at Meramec, with 98 specimens being collected during sampling (Section 2.3.1, Table 2-1).

White bass spawn during April through mid-June over rocky or gravelly shoal areas in the river, often making spawning runs into tributaries (Pflieger 1997). They broadcast their eggs, which then adhere to rocks or debris. They provide no parental care. The free-swimming fry and young begin to school and gradually add small fish to their diet. White bass are relatively fast-growing and short-lived. They mature at ages II-III at a length of approximately 8-10 inches (Sallee et al. 2004). White bass in the UMR can reach a maximum length of 18 inches and a maximum weight of 3 pounds.

The UMR provides excellent habitat for white bass in all of its reaches, although the LTRMP data indicate they are slightly more abundant in the southern reaches (including the Meramec area) than in the more northern reaches (Gutreuter and Theiling 1998). White bass are known as channel dwelling, being found schooling in both the main channel and side channels. They also frequent the fast water below wing dams and the tailwaters below navigation dams (Sallee et al. 2004). White bass adults migrate during the spawning season over wide areas of the UMR.

During the past 11 years, white bass upstream and downstream from Meramec were particularly abundant in 1993, the year of the 500-year flood, as shown by LTRMP daytime electrofishing CPUE in both Pool 26 and the Open River Reach (Figures 3-12 and 3-13). After 1993, their abundance has been considerably lower but stable.

3.3.6 Paddlefish

The paddlefish is recommended as a RS because of its importance as a commercial and recreational species, and because the status and health of its population in the UMR has received so much recent attention. It is listed as a commercial and sport fish species in Missouri and Illinois, a sport fish in Iowa, and a species protected from harvest in Minnesota and Wisconsin. The paddlefish is a planktivorous fish which reaches sizes of 60 pounds to 200 pounds (Runstrom et al. 2004), but is harvested at smaller sizes (e.g., an average length of 26 inches and average weight of 12.75 pounds in Illinois). Several states have listed the species as endangered, threatened or species of special concern. In Missouri it is considered rare or uncommon. In 1989, the USFWS was petitioned to list the paddlefish as a threatened species under the Endangered Species Act, but existing data were inadequate to make a final determination. In 1994, the paddlefish was listed as Category 2, defined as a species that may warrant listing but information to do so is lacking. The paddlefish was the seventh-most frequently impinged species at the Meramec Power Plant during the 1974-1975 monitoring program, with 85 individuals being collected during sampling (Section 2.3.1). The appearance of paddlefish in impingement collections generally was restricted to the period from March through July (UEC 1977).

The paddlefish is particularly vulnerable to overharvest because it is late-maturing and is an infrequent spawner. In the UMR, females do not begin to mature until age VI and are not fully mature until age XII. Males start to mature at age IV and are 100 percent mature by age IX (Runstrom et al. 2004). Although there is still some uncertainty about the frequency of their spawning, there is some evidence that females only spawn once every 2 to 5 or so years because ova development may take more than 1 year (Runstrom et al. 2004). Spawning appears to occur in late May, usually timed with an increase in river discharge. Paddlefish spawn in swift currents (1.3-5.2 fps) over gravel and rubble, and their eggs are demersal and adhesive. Young begin filter-feeding at about 5 to 10 inches in length.

There are very limited data on the early life history and distribution for paddlefish. Larvae have been found in the Wisconsin and Chippewa Rivers, tributaries to the UMR, but specific spawning locations are not known (Runstrom et al. 2004). The population dynamics and movements for the species currently are being intensively studied by organizations such as the Mississippi Interstate Cooperative Resource Association (MICRA), whose study will span from 1995 to 2005. It is known that adults strongly select the tailwaters of dams in the spring and summer, and frequently associate with structures such as eddies, holes and current breaks. They can inhabit the main channel border or backwaters, moving to the main channel border as river discharge decreases, and prefer deeper water.

The status of the paddlefish population has been of concern since the early 1900's. Peak harvest of paddlefish occurred in 1899, and harvest levels have continually decreased until they are now less than 10 percent of the 1899 harvest (Runstrom et al. 2004). The decline in its abundance may be attributed to several factors in addition to its late maturity and infrequent spawning. These factors include river modifications for navigation, hydropower and flood control, leading to loss of critical habitat and restricted movements; injury from boat propeller strikes and larval losses from turbulence and shoreline dewatering from boat traffic; and overharvest. Paddlefish are harvested for their valuable flesh and roe, with roe now becoming a more valuable commodity as international caviar supplies decline (Runstrom et al. 2004). Existing data appear to indicate that most populations currently are declining or relatively stable at low levels. Paddlefish face a new threat from potential competition with recently introduced large planktivores, i.e., bighead carp and silver carp.

The great mobility of this species and the long-range movements that it exhibits require that its management be coordinated at the multi-state level, such as the UMRCC and MICRA.

3.3.7 Flathead Catfish

The flathead catfish is a large, predatory riverine catfish species that is less abundant than channel catfish but grows to a larger size (Gutreuter and Theiling 1998). It is actively pursued by commercial fishermen and recreational anglers, and is the object of organized tournaments. Although smaller than the blue catfish, the flathead catfish is capable of reaching trophy sizes, sometimes exceeding 65 pounds while reaching a state record of 98 pounds in Missouri waters (Brummet and Jones 2004). It was the ninth-most frequently impinged fish species during 1974-1975 monitoring program at Meramec and the most frequently impinged catfish species, with 68 specimens being collected during sampling (Section 2.3.1, Table 2-1).

Flathead catfish spawn in the UMR in late June or early July by excavating depressions in the river substrate, usually near submerged objects, and laying eggs in a golden-yellow mass. The male parent guards the nest until approximately 1 week post-hatching, when the young leave the nest. Flathead catfish mature at ages IV to V or about 18 inches in length (Brummet and Jones 2004). They may live up to 28 years.

Young flathead catfish inhabit shallow riffles and rip-rap areas, feeding mostly at night. Larger fish occupy deeper water but continue to feed at night on other fish and crayfish. A study conducted in Mississippi on the flathead catfish indicated that its abundance was related to the amount of mature forested area in the riparian zone and the amount of snags available in the river (Brummet and Jones 2004). In the UMR, it seems to be more abundant in the Open River Reach and Pool 26, the two LTRMP study areas that bound the river where Meramec is located, than in the more upstream reaches of the UMR. Adult flathead catfish usually have a short home range in the river (e.g., <1 mile), but tagging studies have shown a small percentage (15 percent) to travel distances greater than 20 miles (Brummet and Jones 2004). During warm months, adults can be found in all river habitats except backwaters. In the winter, adults become relatively inactive, staying near structures such as boulders and log piles.

A 15-inch minimum size limit imposed on the commercial fishery for flathead catfish in 1985 appeared to reverse a downward trend in their abundance in the impounded portion of the UMR (Brummet and Jones 2004). Since 1991, flathead catfish have comprised approximately 15 percent of the commercial harvest according to UMRCC records, and their value has been increasing in the past 20-30 years. LTRMP data from the past 11 years indicate daytime electrofishing CPUE has remained fairly constant except for a possible increase in the Open River reach beginning in 2002 (Figures 3-14 and 3-15).

3.3.8 Sauger

Of all the game species in the UMR, one of the most prized by anglers is the sauger. It is an extremely important recreational species in the UMR, as indicated by its ranking either first or second in harvest in Pool 4 during the late 1980's and early 1990's (Pitlo et al. 2004). It is a highly managed species. Presently, the five UMR states have agreed to keep the fishing season open year-round with no size limits based on its ability to maintain its harvest under these regulations. It was the tenth-most frequently impinged fish species during 1974-1975 monitoring program at Meramec, with 67 specimens being collected during sampling (Section 2.3.1, Table 2-1).

Like other members of the perch family, sauger spawn earlier in the spring than many other species. Sauger generally spawn during late March through April, when water temperatures are 40-52°F (Pitlo et al. 2004). Spawning sites in the UMR are not well documented, but may include the area around wing dams, side channel margins with sand substrates, or shallow water over rip-rap, gravel or mussel beds (Pitlo et al. 2004). Sauger concentrate over spawning grounds for approximately 2 weeks, with males arriving earlier and staying longer. They broadcast their non-adhesive eggs, which settle into the substrate or drift downriver. They grow rapidly and by fall are 5 to 8 inches in length. By age I they are primarily piscivorous. Most males are mature by age II and most females are mature by age III, at around 11 to 15 inches in length (Pitlo et al. 2004). Major food items for sauger are gizzard shad and shiners.

Young sauger can be found in almost all habitats in the river, but it appears they prefer sand substrates. LTRMP electrofishing CPUE data indicate that sauger may be less abundant in the Open River Reach than the other UMR reaches (Gutreuter and Theiling 1998). Sauger are more tolerant of turbidity, such as occurs in the open river in the vicinity of Meramec, than its close relative, the walleye. Adults are adaptable to many habitats. Tailwater areas below dams yield the highest catches, but they are also abundant along wing dams and the open channel (Pitlo et al. 2004). They may move great distances to overwinter in pools and tailwaters.

Sauger exhibit wide fluctuations in first year recruitment, which may be related to the thermal environment (e.g., rapidly warming temperatures conducive to growth and survival) or river discharge fluctuations in the spring (Pitlo et al. 2004). Year class strength appears to be established by age III. Most data on annual sauger abundance comes from the pooled reaches of the UMR. The UMR population otherwise appears to be stable and thriving, with no discernable long-term trends over 36 years of data (Pitlo et al. 2004). No consistent trends in abundance were found in the most recent 11 years of LTRMP data.

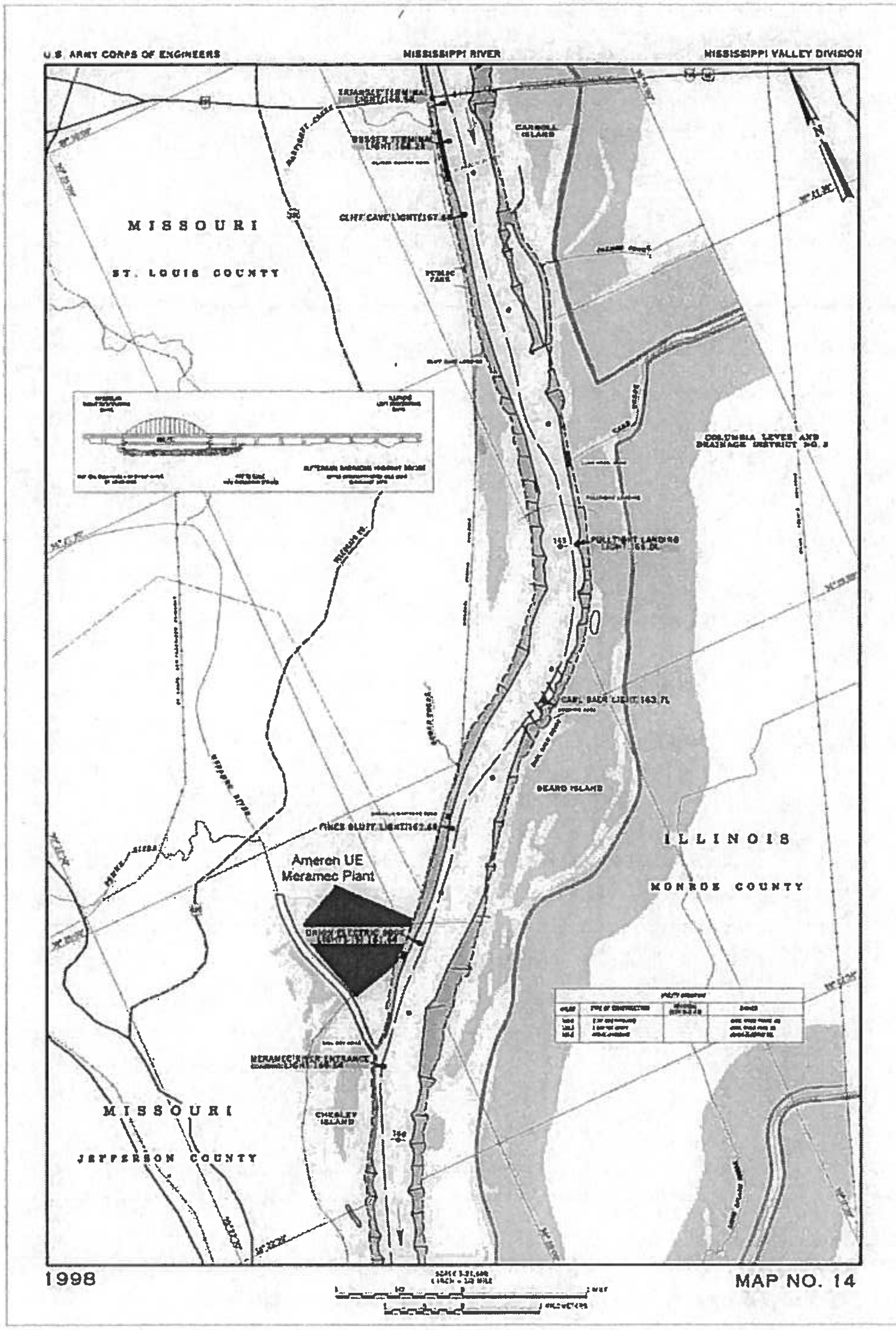
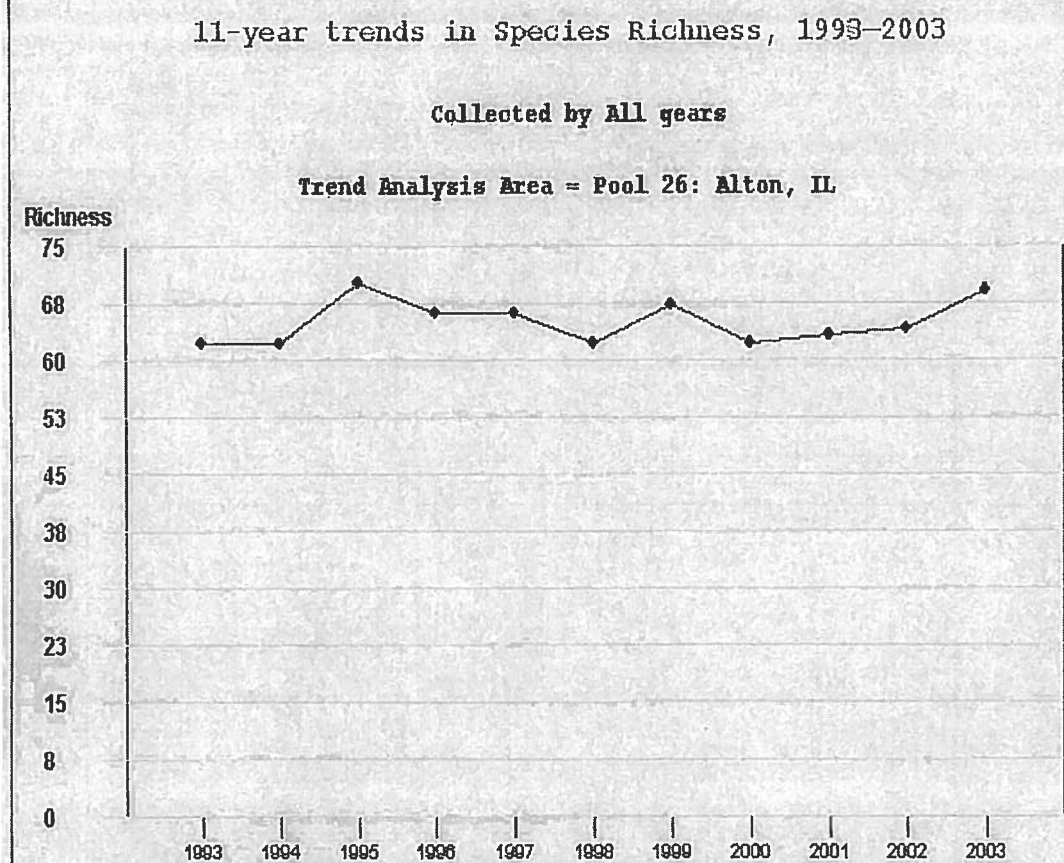


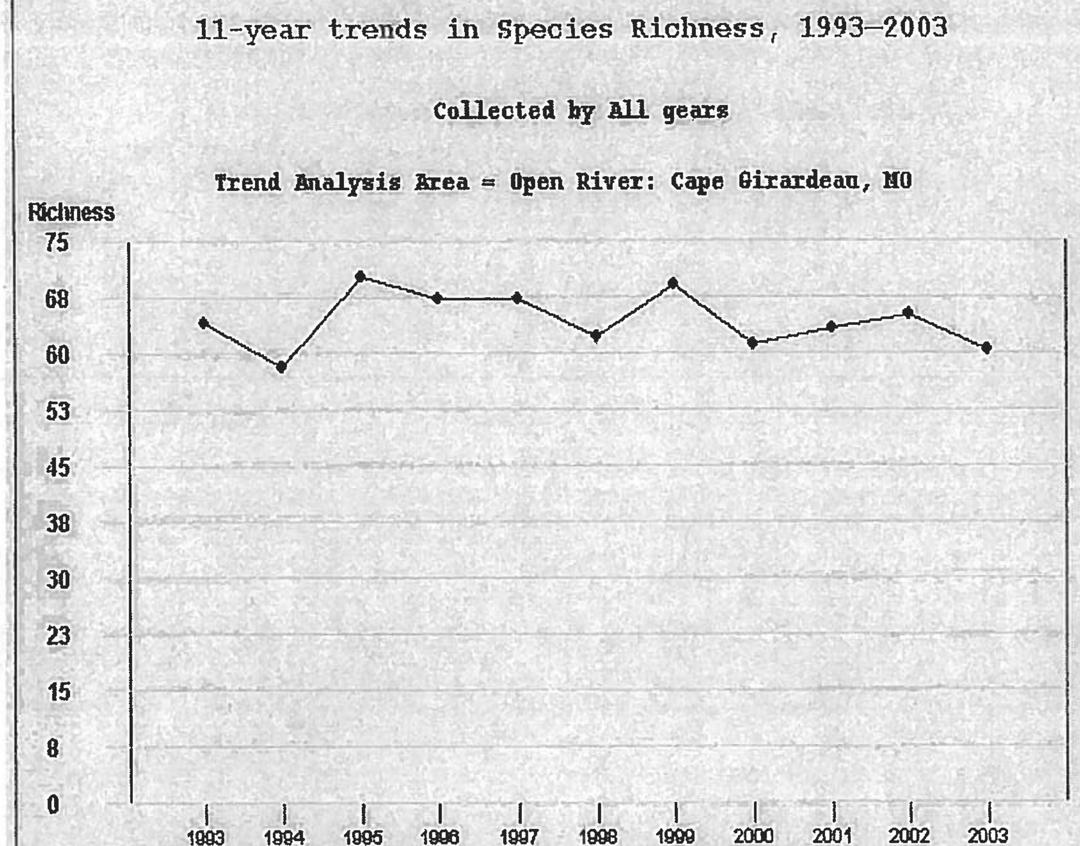
Figure 3-1 Map of Mississippi River in the vicinity of the Meramec intake (Ameren UE dock lights) showing wing dams (horizontal lines) and shoals on east side of the river.



Year	Richness	Number of Samples
1993	62	116
1994	62	383
1995	70	383
1996	66	387
1997	66	385
1998	62	364
1999	67	371
2000	62	380
2001	63	383
2002	64	272
2003	69	273

N/A equals not applicable.

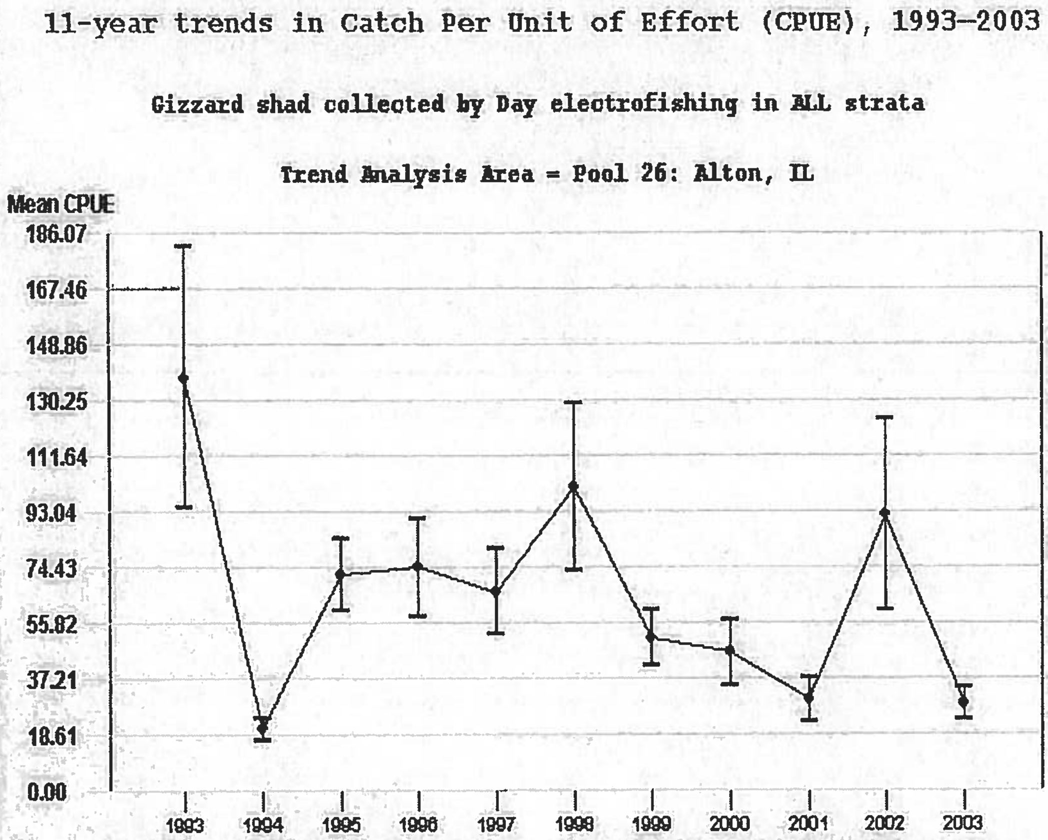
Figure 3-2 Eleven-year trend in species richness (Pool 26: Alton, IL).



Year	Richness	Number of Samples
1993	64	97
1994	58	282
1995	70	280
1996	67	319
1997	67	371
1998	62	241
1999	69	277
2000	61	297
2001	63	302
2002	65	247
2003	60	167

N/A equals not applicable.

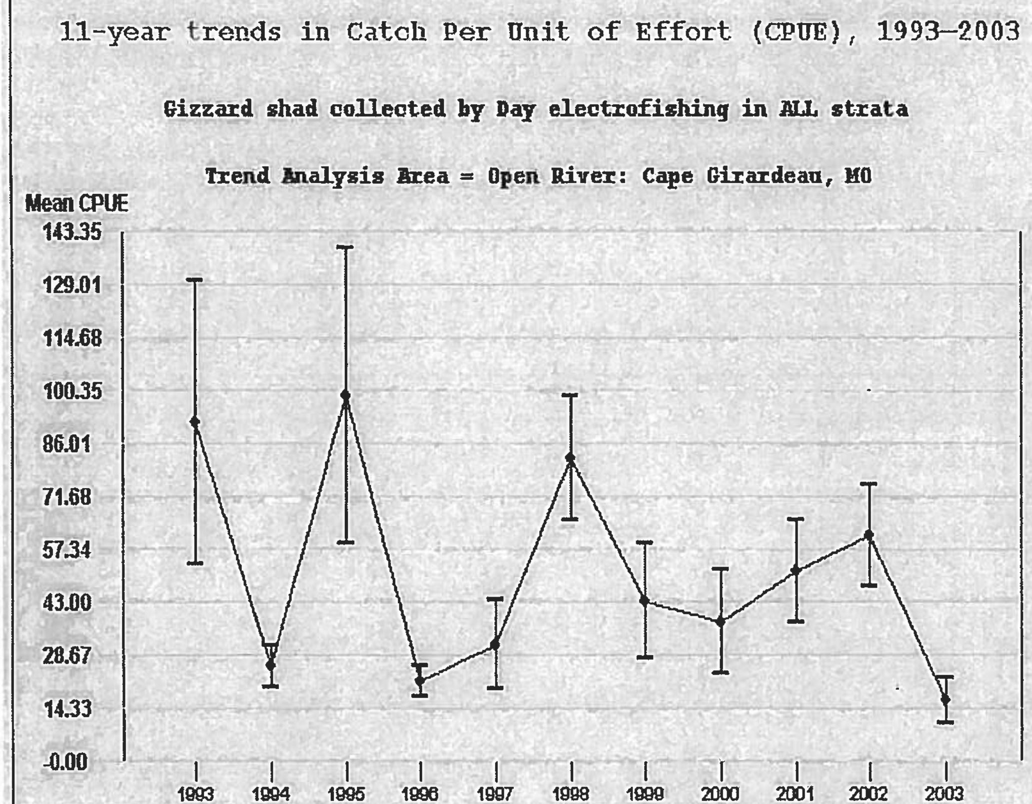
Figure 3-3 Eleven-year trend in species richness (Open River: Cape Girardeau, MO).



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	137.40	181.07	93.75	33
1994	19.94	23.81	16.08	78
1995	71.49	83.61	59.38	77
1996	73.85	90.33	57.38	78
1997	65.73	80.20	51.28	77
1998	100.50	128.36	72.65	76
1999	49.94	59.26	40.63	76
2000	45.23	55.93	34.53	78
2001	29.55	37.00	22.11	77
2002	91.65	123.54	59.76	77
2003	28.10	33.25	22.94	78

N/A equals not applicable.

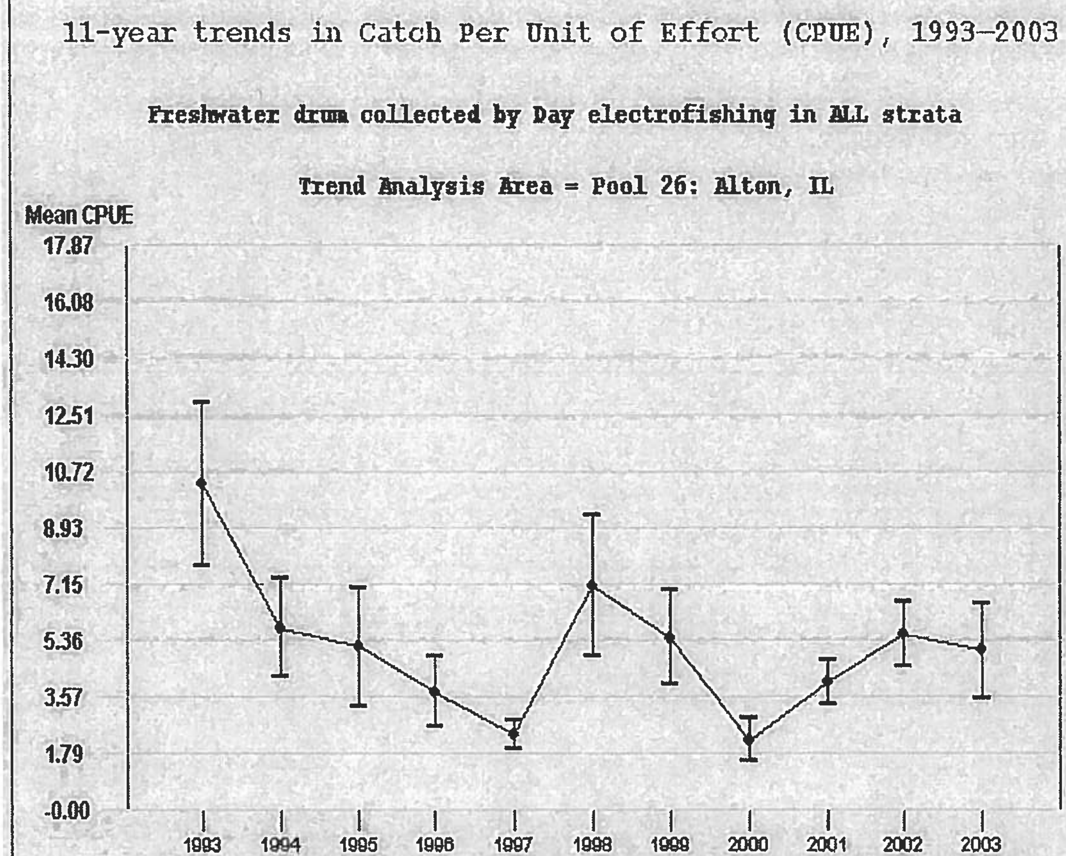
Figure 3-4 Eleven-year trend in catch of gizzard shad (Pool 26: Alton, IL).



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	91.45	129.78	53.13	17
1994	25.14	30.79	19.49	42
1995	98.47	138.35	58.60	54
1996	21.06	25.12	17.01	52
1997	31.15	43.02	19.28	55
1998	81.62	98.50	64.75	37
1999	42.89	58.62	27.17	49
2000	37.26	51.42	23.10	53
2001	51.01	64.67	37.36	57
2002	60.74	74.72	46.75	57
2003	16.19	22.28	10.09	27

N/A equals not applicable.

Figure 3-5 Eleven-year trend in catch of gizzard shad (Open River: Cape Girardeau, MO).



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	10.28	12.87	7.70	33
1994	5.71	7.28	4.16	78
1995	5.11	6.98	3.25	77
1996	3.70	4.85	2.56	78
1997	2.31	2.77	1.86	77
1998	7.06	9.31	4.83	76
1999	5.40	6.92	3.90	76
2000	2.16	2.86	1.47	78
2001	3.99	4.68	3.30	77
2002	5.52	6.57	4.47	77
2003	4.98	6.46	3.49	78

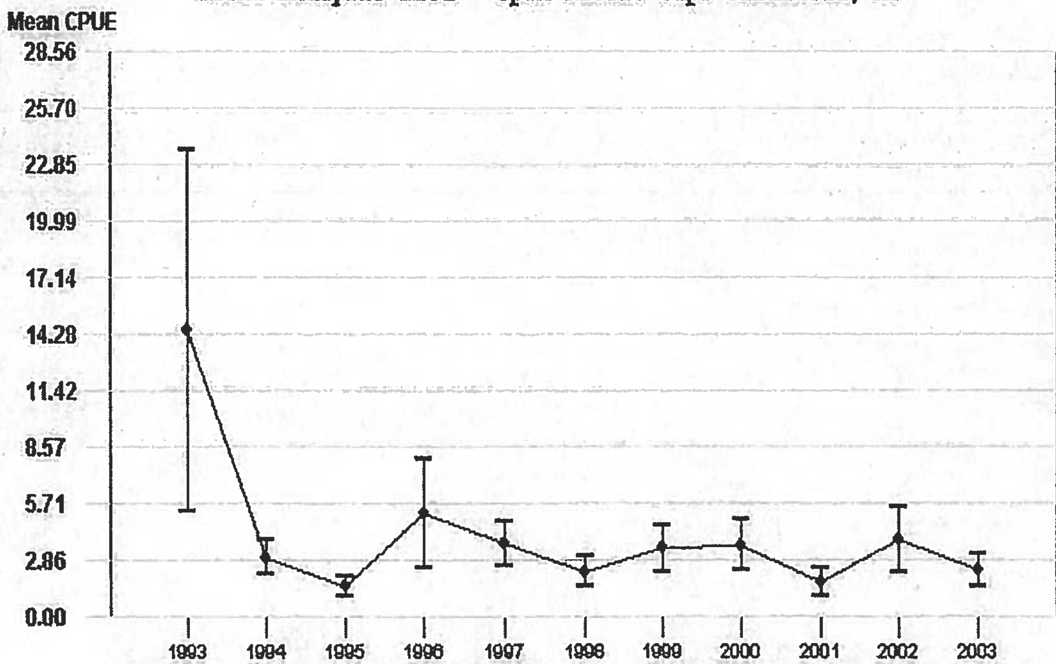
N/A equals not applicable.

Figure 3-6 Eleven-year trend in catch of freshwater drum (Pool 26: Alton, IL).

11-year trends in Catch Per Unit of Effort (CPUE), 1993–2003

Freshwater drum collected by Day electrofishing in ALL strata

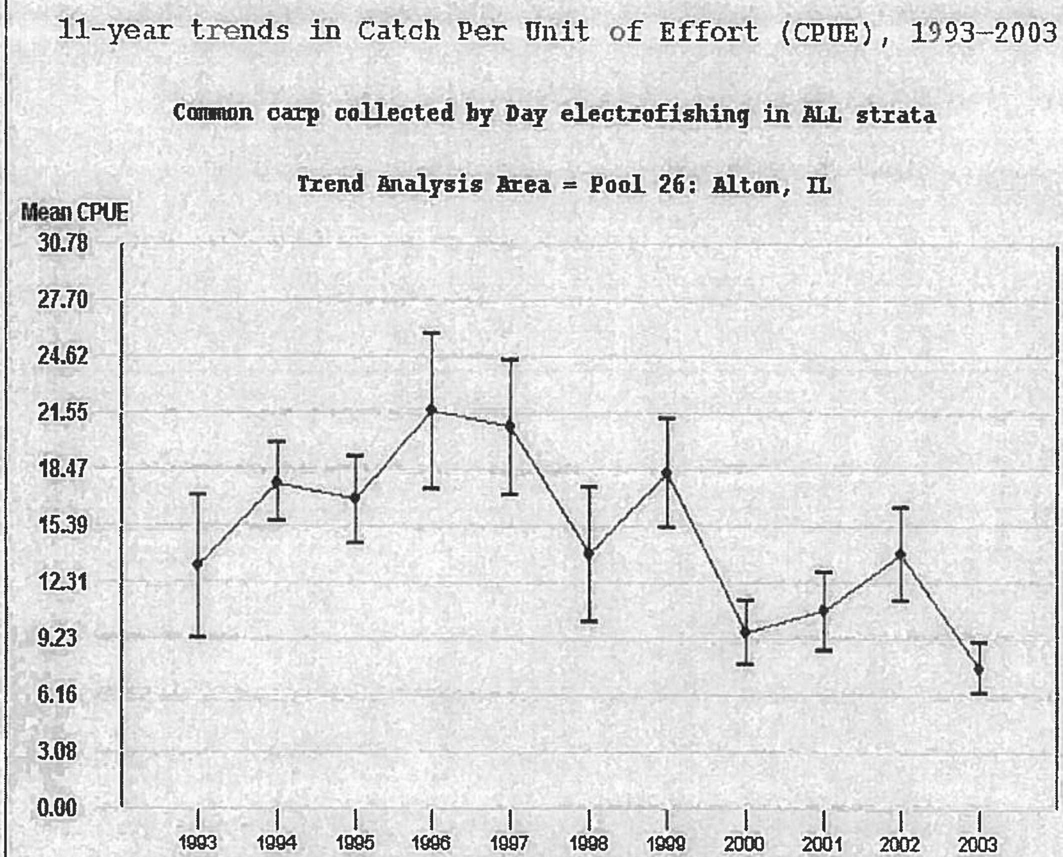
Trend Analysis Area = Open River: Cape Girardeau, MO



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	14.40	23.56	5.26	17
1994	2.95	3.84	2.06	42
1995	1.53	2.04	1.02	54
1996	5.14	7.89	2.40	52
1997	3.63	4.79	2.48	55
1998	2.24	2.99	1.50	37
1999	3.39	4.58	2.21	49
2000	3.55	4.82	2.30	53
2001	1.66	2.42	0.92	57
2002	3.82	5.45	2.19	57
2003	2.30	3.16	1.44	27

N/A equals not applicable.

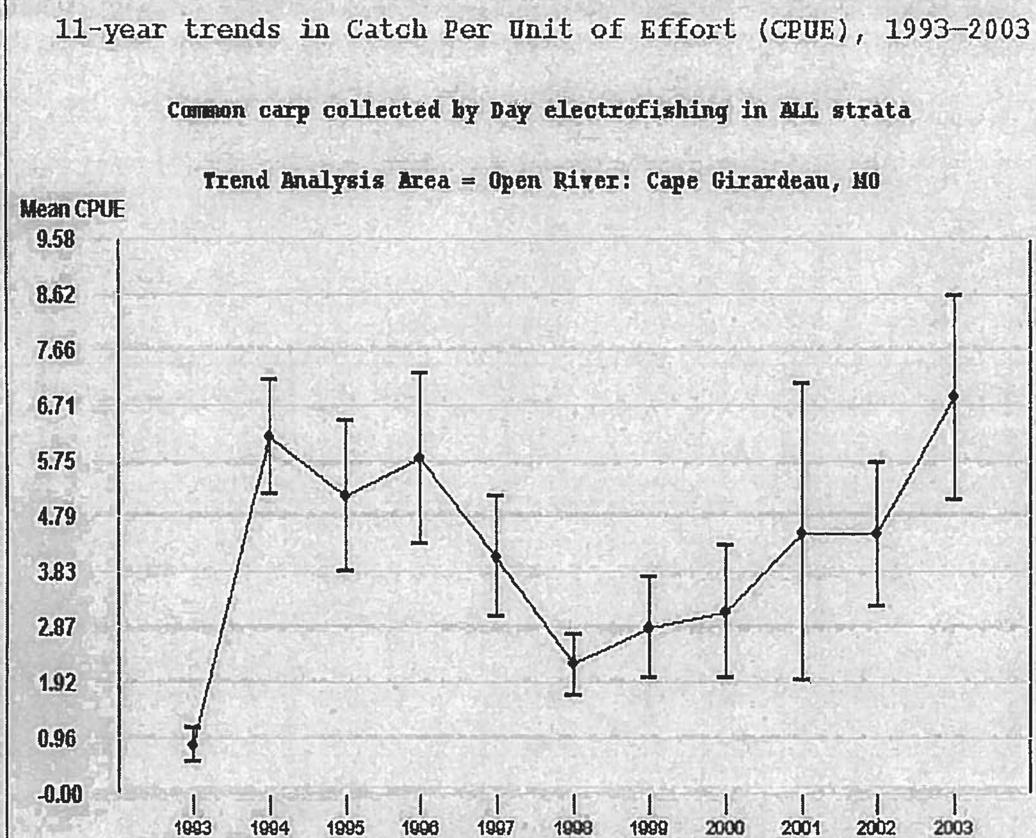
Figure 3-7 Eleven-year trend in catch of freshwater drum (Open River: Cape Girardeau, MO).



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	13.09	16.96	9.22	33
1994	17.65	19.80	15.52	78
1995	16.72	19.12	14.34	77
1996	21.55	25.78	17.32	78
1997	20.68	24.35	17.02	77
1998	13.77	17.44	10.11	76
1999	18.16	21.12	15.22	76
2000	9.49	11.27	7.72	78
2001	10.71	12.86	8.57	77
2002	13.79	16.28	11.30	77
2003	7.56	8.94	6.18	78

N/A equals not applicable.

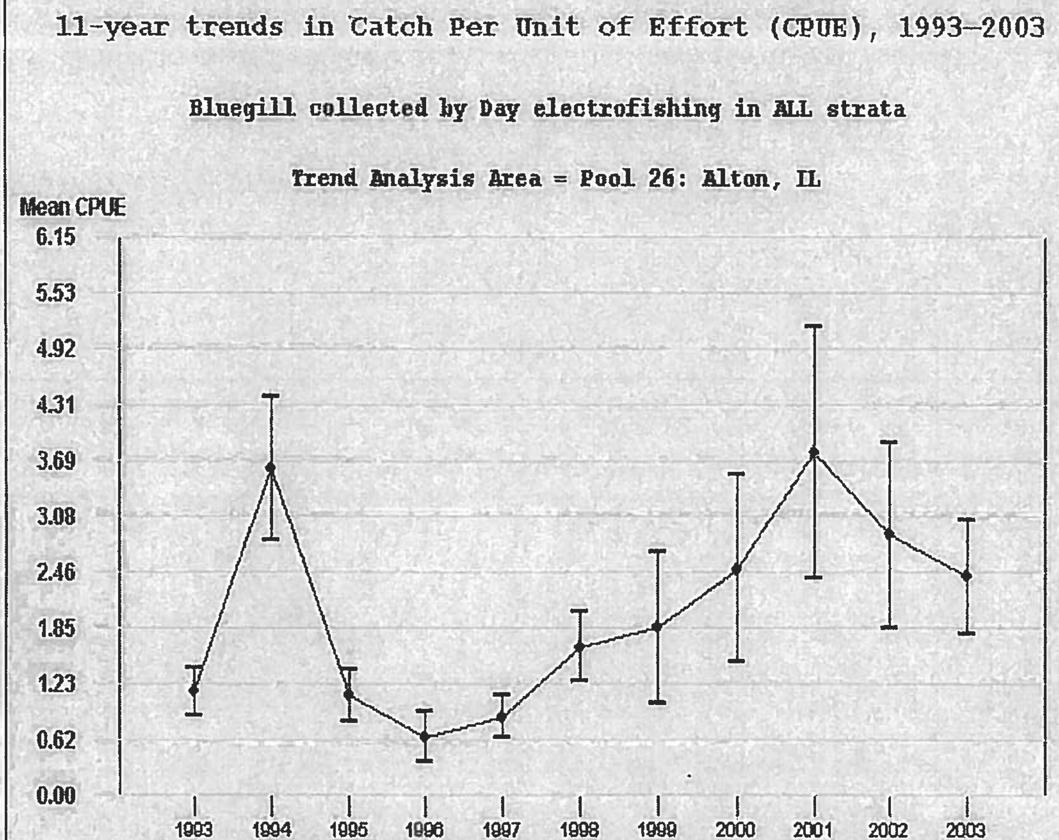
Figure 3-8 Eleven-year trend in catch of common carp (Pool 26: Alton, IL).



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	0.81	1.10	0.53	17
1994	6.14	7.14	5.16	42
1995	5.12	6.43	3.83	54
1996	5.77	7.23	4.31	52
1997	4.07	5.10	3.04	55
1998	2.19	2.73	1.65	37
1999	2.82	3.70	1.96	49
2000	3.11	4.25	1.98	53
2001	4.48	7.05	1.93	57
2002	4.45	5.68	3.21	57
2003	6.81	8.58	5.05	27

N/A equals not applicable.

Figure 3-9 Eleven-year trend in catch of common carp (Open River: Cape Girardeau, MO).



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	1.13	1.40	0.86	33
1994	3.59	4.39	2.80	78
1995	1.08	1.37	0.80	77
1996	0.63	0.91	0.37	78
1997	0.85	1.08	0.62	77
1998	1.62	2.02	1.24	76
1999	1.83	2.67	1.00	76
2000	2.48	3.52	1.45	78
2001	3.77	5.15	2.39	77
2002	2.86	3.87	1.84	77
2003	2.40	3.03	1.76	78

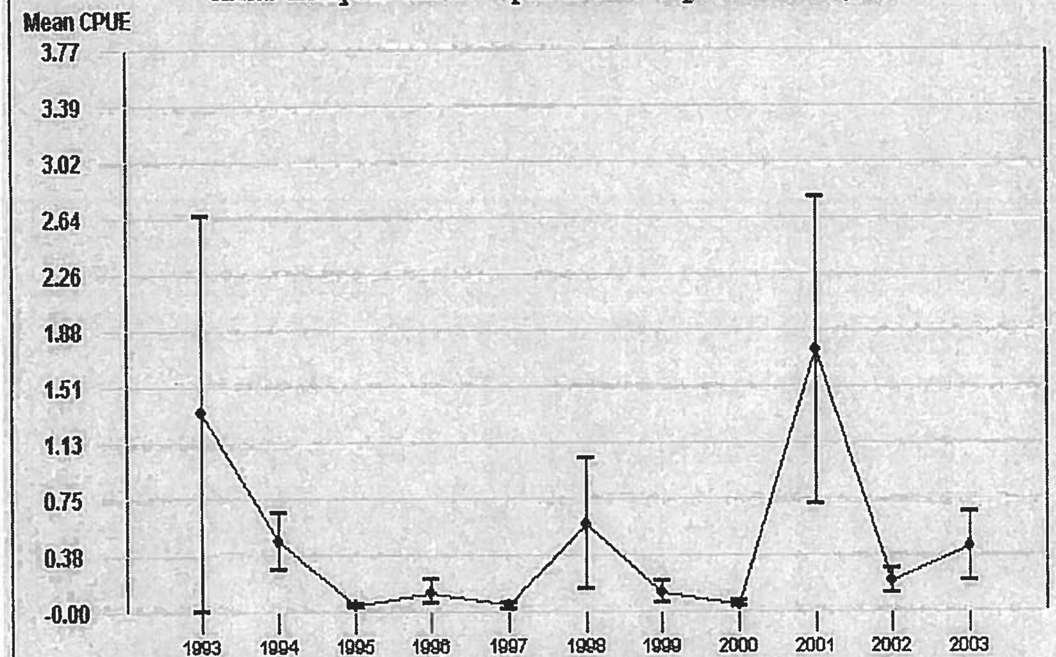
N/A equals not applicable.

Figure 3-10 Eleven-year trend in catch of bluegill (Pool 26: Alton, IL).

11-year trends in Catch Per Unit of Effort (CPUE), 1993–2003

Bluegill collected by Day electrofishing in ALL strata

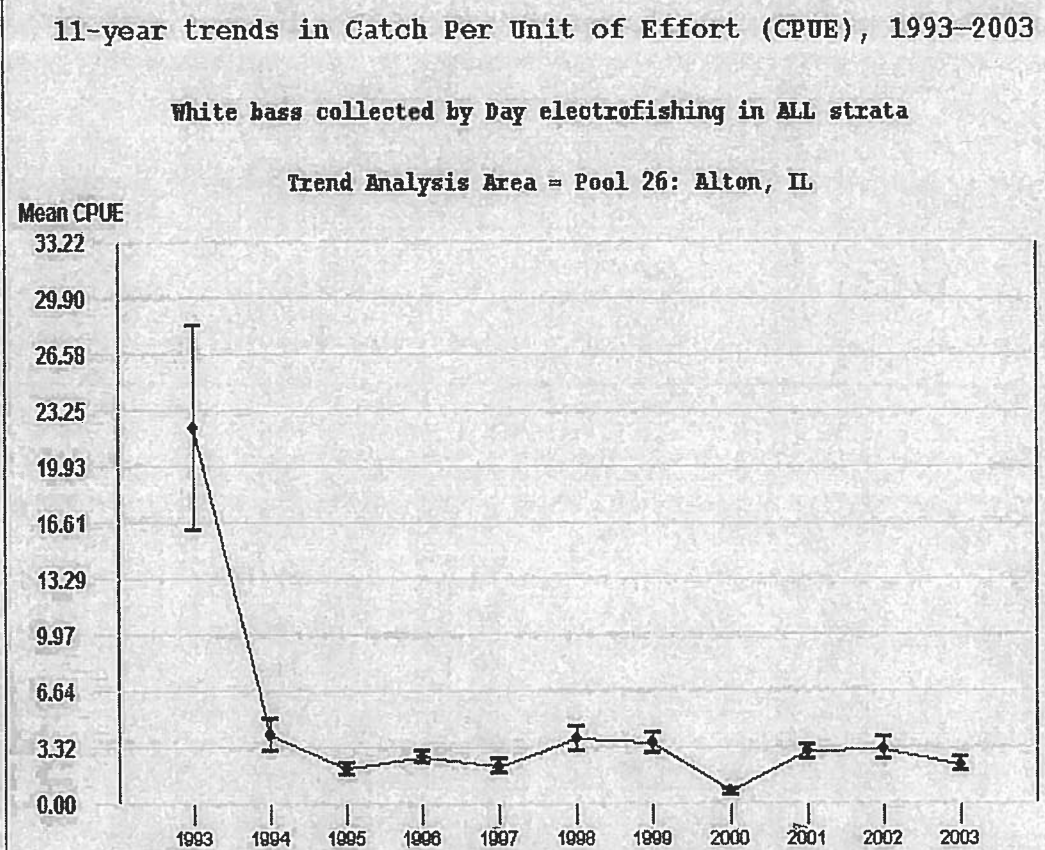
Trend Analysis Area = Open River: Cape Girardeau, MO



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	1.32	2.64	0.00	17
1994	0.46	0.65	0.28	42
1995	0.03	0.05	0.02	54
1996	0.12	0.21	0.05	52
1997	0.03	0.05	0.01	55
1998	0.57	1.02	0.14	37
1999	0.12	0.20	0.05	49
2000	0.04	0.06	0.02	53
2001	1.74	2.77	0.71	57
2002	0.19	0.27	0.11	57
2003	0.43	0.65	0.20	27

N/A equals not applicable.

Figure 3-11 Eleven-year trend in catch of bluegill (Open River: Cape Girardeau, MO).



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	22.15	28.22	16.09	33
1994	3.92	4.87	2.98	78
1995	1.93	2.28	1.58	77
1996	2.68	3.06	2.32	78
1997	2.13	2.59	1.69	77
1998	3.73	4.40	3.07	76
1999	3.48	4.13	2.85	76
2000	0.61	0.75	0.47	78
2001	2.97	3.43	2.52	77
2002	3.18	3.81	2.55	77
2003	2.22	2.66	1.78	78

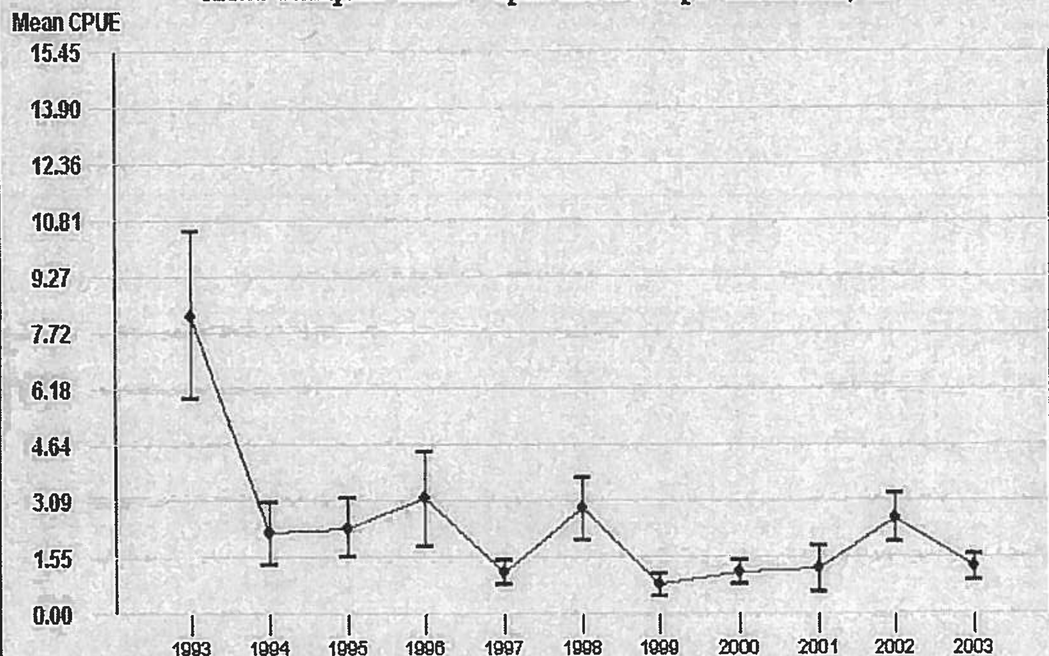
N/A equals not applicable.

Figure 3-12 Eleven-year trend in catch of white bass (Pool 26: Alton, IL).

11-year trends in Catch Per Unit of Effort (CPUE), 1993–2003

White bass collected by Day electrofishing in ALL strata

Trend Analysis Area = Open River: Cape Girardeau, MO



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	8.14	10.45	5.85	17
1994	2.16	3.02	1.32	42
1995	2.31	3.12	1.51	54
1996	3.09	4.38	1.80	52
1997	1.10	1.43	0.77	55
1998	2.82	3.68	1.97	37
1999	0.73	1.02	0.44	49
2000	1.07	1.40	0.74	53
2001	1.17	1.82	0.53	57
2002	2.57	3.23	1.90	57
2003	1.23	1.60	0.87	27

N/A equals not applicable.

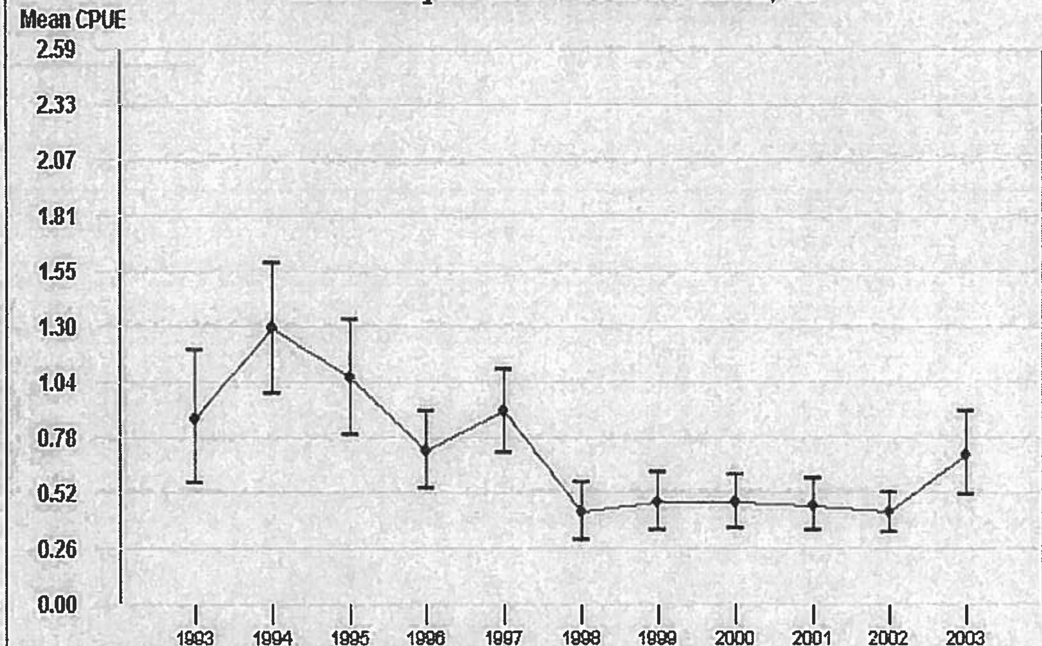
Figure 3-13 Eleven-year trend in catch of white bass (Open River: Cape Girardeau, MO).

Figure 3-13

11-year trends in Catch Per Unit of Effort (CPUE), 1993–2003

Flathead catfish collected by Day electrofishing in ALL strata

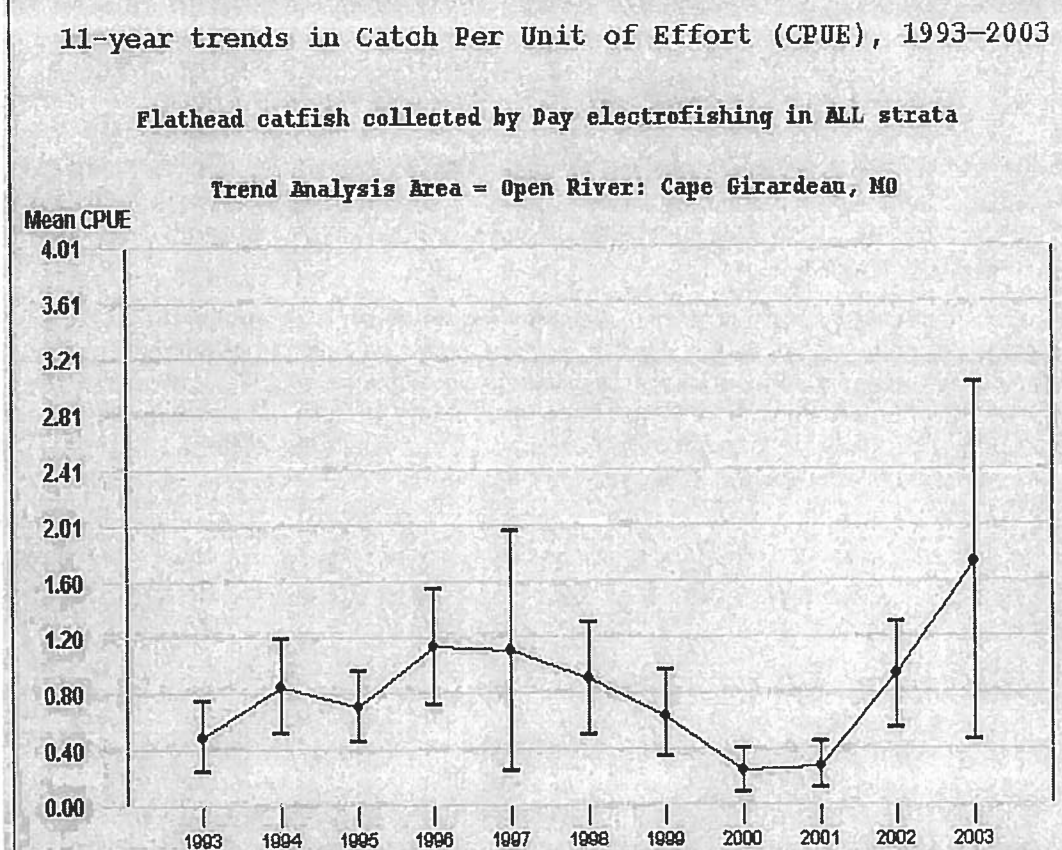
Trend Analysis Area = Pool 26: Alton, IL



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	0.86	1.18	0.56	33
1994	1.28	1.59	0.98	78
1995	1.05	1.32	0.78	77
1996	0.71	0.89	0.53	78
1997	0.89	1.09	0.70	77
1998	0.42	0.56	0.29	76
1999	0.47	0.61	0.34	76
2000	0.47	0.60	0.35	78
2001	0.45	0.58	0.34	77
2002	0.42	0.51	0.33	77
2003	0.69	0.89	0.50	78

N/A equals not applicable.

Figure 3-14 Eleven-year trend in catch of flathead catfish (Pool 26: Alton, IL).



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	0.48	0.74	0.23	17
1994	0.84	1.18	0.51	42
1995	0.69	0.95	0.45	54
1996	1.12	1.54	0.71	52
1997	1.10	1.96	0.24	55
1998	0.89	1.29	0.50	37
1999	0.63	0.95	0.33	49
2000	0.24	0.40	0.08	53
2001	0.26	0.43	0.11	57
2002	0.92	1.30	0.54	57
2003	1.73	3.01	0.45	27

N/A equals not applicable.

Figure 3-15 Eleven-year trend in catch of flathead catfish (Open River: Cape Girardeau, MO).

4. PROPOSED IMPINGEMENT MONITORING

As discussed in Section 2.3.4, impingement data were collected at the Meramec Power Plant during the 1974-1975 impingement monitoring program and during the winter of 1977-1978. This sampling provided useful data on the magnitude of impingement at Meramec during that time period. However, the plant's intake screening configuration, plant operation, and the fish community in the middle Mississippi River may have changed sufficiently since then to affect impingement at Meramec, in particular the species composition and magnitude of impingement.

The objective of the proposed impingement monitoring program is to update the existing impingement data to reflect current conditions in the river and current operation of the plant. Data produced by this monitoring program will define the species and life stages impinged, as well as their numbers and biomass on a time (biweekly, monthly, and annual) and per-volume-pumped (million gallons of cooling water) basis. The results will be incorporated into the IM Characterization Study, as described in Section 1.2.

This section addresses the proposed sampling plan, sampling gear and the method for its deployment, sample processing procedures, the collection of relevant ancillary information, and data analysis. A quality assurance program for the impingement monitoring program is described in Section 5.

4.1 SAMPLING DESIGN

The impingement monitoring program is recommended to span at least one year (12 months) and to include all four units. A second year of monitoring may not be necessary if the magnitude of impingement and/or the species and life stages impinged do not differ markedly from the results of the 1974-1975 monitoring program, e.g., seasonal or annual impingement totals or rates (average daily or average number per unit volume pumped).

Impingement will be sampled every other week and the traveling screens of all operating units will be sampled at the same time. If no units are scheduled to operate during the specified biweekly sampling period, a request will be made to turn on a circulating water pump for the duration of sampling in order to get representative density measurements. This biweekly sampling frequency will describe seasonal patterns in impingement as requested in the Phase II Rule.

Sampling will occur over one 24-hour period per biweekly period. Sampling days will be scheduled for the same day(s) in each period (e.g., Tuesday).

4.2 SAMPLING GEAR AND DEPLOYMENT

Prior to sampling, the traveling screens will be rotated for at least one full cycle to remove fish and debris accumulated prior to the sampling interval. Once this cleaning process has been accomplished, the sampling will be initiated by lowering a collection basket into the screen wash trough system that serves all four units. The screens will be rotated during the sampling period in a manner typical of normal screen operation, i.e., they will be washed with a frequency necessary to keep them clean. The collection basket will have ¼-inch square mesh. The sampling crew will monitor the screen wash troughs and collection basket to prevent overflow or snags caused by debris buildup. During periods of very low volume of impinged fish and debris, the collection basket may be left in place for the entire

24-hour collection period. When fish and debris volumes become greater, screens from individual units will be rotated and washed sequentially and as frequently as necessary to reduce the volume of debris and fish being directed to the collection basket at once. For example, Unit 1 screens will be washed and the sample will be retrieved in the collection basket prior to rotating and washing the screens for each of the other three units. At the completion of each sampling, the collection basket will be removed and its contents will be emptied onto a processing table.

If necessary, screen rotation will be continuous at all screens. In this case, the sampling crew will continuously monitor the screen washwater troughs and the collection basket to prevent snags or overflow caused by ice or debris buildup. To prevent collection basket overflow, the crew will temporarily interrupt sampling, empty the collection basket's contents, and resume sampling, while recording the start and end times of the interruption. If this occurs, the total impingement during the 24-hour sampling period will be estimated by extrapolating from the timed subsamples to a full 24-hour sample.

4.3 SAMPLE PROCESSING

Each sample will be processed by counting and identifying all fish to the lowest practicable taxonomic level. Individual fish that cannot be identified to species in the field will be preserved for identification by taxonomic specialists. Shellfish found in the impingement sample, such as native freshwater mussels, Asiatic clams, zebra or quagga mussels, and crayfish, will be identified to a practicable taxonomic level and will be counted (in the case of few specimens such as native freshwater mussels or crayfish) or weighed in bulk (in the case of numerous Asiatic clams or zebra and quagga mussels).

Fish in the sample will be sorted by species and size category. Two size categories will be established prior to sampling, if possible, to separate young-of-the-year (YOY) individuals from yearling and older individuals. Size categories will be determined according to cut-off lengths used during the previous biweekly sampling period and anticipated growth, based on observation and literature sources. Following sorting, up to 50 randomly chosen individual specimens within each size category will be measured to the nearest mm total length (TL) and their condition will be recorded as live, dead or stunned. A total batch weight measurement will be taken for each size category.

If the number of specimens in the sample for a particular species and size category is large, then the species/size category count will be estimated by subsampling. A subsample of 100 individuals will be weighed and the total sample will be weighed. The number of individuals in the whole sample will be estimated from the ratio of the total sample weight to the subsample weight total and the count within the subsample. Lengths will be measured for 50 randomly chosen individuals in the subsample.

During each season (e.g., April-June, July-September), scales, finrays, spines or otoliths (depending on species) from 20 measured yearling and older individuals of each of the representative fish species from each 50-mm length interval (e.g., 200 – 249 mm, 250 – 299 mm, etc.) will be removed and stored in individual envelopes or vials. For each sampled fish, the collection date and location, species, and total length will be recorded. These samples may be used, if necessary, to supplement recent size-specific age data available from literature sources for species in the middle Mississippi River. Size-specific age data may be required for application of equivalent loss models as part of a site-specific cost-benefit calculation.

The general condition of impinged fish will be observed as they are processed. Unusual condition, such as signs of disease, parasites or injury, will be noted. Fish that were obviously dead before being impinged (e.g., presence of fungus or decay) will not be included in the sample. Indications of a mass die-off of fish, such as can occur with gizzard shad (White et al. 1986), will be observed and recorded, and examples of physical evidence (e.g., floating fish in the river or dead fish on shore) will be photo-documented. If available, scientifically defensible methods to detect or predict the occurrence of moribund fish entering the intake will be used to document episodic impingement events that would represent anomalous impingement data. Samples may be frozen and saved at the completion of processing, for possible inclusion in quality control (QC) testing. Once it is determined that a sample is no longer needed for QC purposes, the sample will be disposed of in an approved manner. QC of sample processing is discussed in Section 5.

4.4 RELEVANT ANCILLARY INFORMATION

There is ancillary information that must be recorded relevant to environmental conditions at the time of impingement monitoring, as well as plant operation data needed to estimate total impingement. Environmental data relevant to each sample will be recorded on an accompanying field data sheet. In addition to date and sample start/end time recordings, these data will include operation parameters for the intake (identify screens and pumps operating), river stage, and water temperature, all recorded at the beginning and end of each collection period. A unique sample identification number will be assigned to each sample. Other relevant observations will be recorded, including river and weather conditions, such as air temperature, wind speed, cloud cover, and precipitation.

Plant operation records will be used to determine the operation regime during the sampled and unsampled days in each month. Data will include hourly pumping rates (or volumes) for each unit, generation output (MWh) and discharge water temperature. Pumping rate or volume data will allow impingement estimates to be based on per unit volume pumped.

4.5 DATA ANALYSIS

The objectives of the impingement data analysis will be to:

1. define the fish species impinged;
2. estimate impingement rates expressed as density per million gallons (MG) of cooling water pumped on a daily, biweekly, and annual basis;
3. estimate total numbers and biomass by species on a daily, biweekly (for seasonal variability), and annual basis for the year of sampling; and
4. characterize impinged fish in terms of size and age distribution by species.

These parameters will be compared to the results of impingement sampling from the 1974-1975 monitoring program to determine whether there are differences that would suggest possibly significant annual variability in impingement at Meramec. If annual variability is determined to be of concern, a second year of impingement monitoring may be considered, as deemed necessary by Ameren to support the submittal of the CDS. The results will be incorporated into the IM Characterization Study in the CDS, as discussed in Section 1.2.

The estimated total numbers and biomass impinged will represent the actual impingement for the year of sampling. However, the impingement rates expressed as density per million gallons (MG) of cooling water pumped can be used to estimate impingement totals under differing operating scenarios, such as might be required to determine the calculation baseline for the station. To estimate the density of impinged organisms for a particular species, the number of fish of that species collected from all screens will be divided by the total intake flow during the 24-hour sampling period. This density estimate then will be multiplied by the total intake flow during the biweekly period to estimate the total number of impinged fish for the biweekly period. Seasonal totals will be calculated by summing the biweekly totals falling within the season. Annual totals will be the sum of all biweekly totals. The same calculations will be performed for estimating total biomass impinged using weight totals. Plant operation records (hourly pumping rates or volumes for each unit) for sampled and unsampled days in each month will be used to perform this extrapolation.

5. QUALITY ASSURANCE

An essential part of the proposed monitoring program will be a quality assurance plan instituted to ensure that the data generated by the program meet an acceptable standard of quality. Quality assurance (QA) is defined as an integrated system involving quality planning, quality control, quality assessment, quality reporting, and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. The EPA has published guidance documents (e.g., EPA 2000, 2002a, 2002b) for preparing and implementing project-specific quality assurance plans for their staff and for contractors funded by their organizations to follow, known as Quality Assurance Project Plans (QAPPs). These documents will be used to prepare a QAPP that fits the needs of the proposed impingement program prior to the initiation of sampling.

A QAPP has four basic element groups: project management, data generation and acquisition, assessment and oversight, and data validation and usability. The following highlights aspects that are particularly relevant to the execution of the proposed impingement monitoring program.

5.1 PROGRAM MANAGEMENT

This Impingement Mortality Sampling Plan provides many of the elements necessary for the program management functions of a QAPP, such as problem definition and background, and project and task descriptions. Other program management functions of a QAPP that are provided in the Plan include presentation of the project objectives and the interrelationships among the project tasks that direct the course of studies and identify information endpoints. An important element is the project organization, which identifies the roles and responsibilities of project personnel. A project organization chart identifies project personnel, whose qualifications (e.g., experience and specialized training) can be reviewed, as well as lines of communication and authority. The project organization chart will show individuals whose responsibility is to conduct various aspects of the quality assurance program.

The QAPP will set data quality objectives and criteria. Methods are specified to ensure a desired level of precision, comparability, and completeness. In terms of impingement mortality quantification, the EPA has not set standards for precision of estimates, so the sampling design proposed in this Plan is intended to conform to sampling effort, and hopefully precision levels, that are currently standard practice. If the EPA publishes guidance on sampling methods in the future, including QA standards and desired or required levels of precision, the program design and methodology address those standards.

5.2 DATA GENERATION AND ACQUISITION

This component of the QA program is the heart of the field and laboratory tasks undertaken to collect (generate) data on current impingement mortality at Meramec. Elements include sampling design, sampling methods, sample handling and custody, analytical methods, instrument maintenance and calibration, and quality control. Quality control is defined as activities whose purpose is to measure and control the quality of a procedure so that it meets the needs of its user. Quality control (QC) activities monitor the outgoing quality of the data and can lead to response actions to bring the data within control limits through various actions, such as retraining of personnel, repair or recalibration of equipment, or other similar actions.

Sampling methods will be standardized so that they are repeatable and produce data that are comparable through time. This will be accomplished by preparing detailed Standard Operating Procedures (SOPs) for all activities, including sampling location and frequency, sampling gear and deployment, sample processing, data coding and recording, database entry, and to some degree, data analysis. The SOPs can be reviewed by all parties to reach consensus on their applicability, and will be adhered to by all project personnel. SOPs will provide a description of procedures to follow if obstacles to sampling or completion of all sampling activities are met, so that the acquisition of quality data can be maximized. The SOPs will describe procedures for sample handling and custody, including required signatures and blank forms for associated labels and logs. Also included will be project-specific data sheets, variable definitions and coding instructions. Equipment and instrument specifications will be described, including levels of precision and calibration methods for ensuring accuracy.

Systematic QC procedures will be instituted to verify recorded data. The primary area where these QC procedures will be used is sample processing, e.g., sorting of impinged fish from debris in the collections, fish counts, species identification, and length and weight measurements. Processed impingement samples will be subjected to a statistically-based QC procedure, such as continuous sampling plans (CSP) or MIL-STD 105 methodology derived from a manufacturing environment and applied to environmental monitoring programs (Young et al. 1992). The sampling plans implemented under these procedures have a specified average outgoing quality limit (AOQL), which represents the maximum fraction of all items (e.g., measurements, taxonomic identifications or counts) or lots (e.g., whole samples) that could be defective as a worst case. A defective item could be a measurement or count that falls outside of a specified tolerance limit (e.g., plus or minus 1 to 10 percent). In practice, the average outgoing quality (AOQ) is typically much better than the AOQL.

5.3 ASSESSMENT AND OVERSIGHT

Assessment and oversight is the process of determining whether the QA plan is being implemented as designed. For the proposed programs, this will be accomplished primarily by conducting technical audits or surveillance of field, laboratory and data management activities (EPA 2000a). Experienced senior staff, designated by the organization chart, will accompany field personnel during a set number of sampling events to observe sampling activities and to verify that SOPs are being followed properly. These auditors also will observe laboratory and data management personnel during their activities on specified occasions. Variances from approved procedures will be documented and corrected, either by modifying SOPs to address any systematic problems or by testing and/or retraining staff, as necessary. Prior to the first scheduled sampling, a readiness review will be conducted to ensure that trained personnel, required equipment, and procedural controls (e.g., SOPs) are in place. A technical audit will be scheduled for the first month of sampling (or very soon thereafter) so that any necessary corrections can be made before significant data losses occur. Follow-up audits will be scheduled (e.g., quarterly) to monitor progress and address changing conditions, such as recruitment of new life stages or species, impingement abundances, river stage or flow, new personnel, or plant operations.

Another QC aspect for oversight is the maintenance of a voucher specimen collection and a library of approved taxonomic keys and references to assist personnel with taxonomic identification. The voucher specimen collection will consist of preserved specimens that have been positively identified by a qualified taxonomist. Oversight also will be provided by procedures requiring that specimens that are not positively identifiable by field or lab personnel will be preserved and given to a qualified taxonomist for identification.

5.4 DATA VERIFICATION, VALIDATION AND USABILITY

Data verification and validation will be conducted by qualified biologists (e.g., QA manager or field/lab supervisors) during the course of the project to ensure that the resulting data will be suitable for use as intended. Project records, including field sampling logs, raw data sheets, sample chain-of-custody forms and instrument calibration logs, will be reviewed to verify that data were collected according to the QAPP. Data will be validated first by a review datasheets and data files to find whether data are incomplete or appear to be inappropriate or out of a reasonable range of values. Data entry into the database also will undergo a 100 percent visual QC comparison to the data on the corresponding data sheets. Finally, data files will be subjected to error checking programs to detect outlying values to either investigate further or eliminate if shown to be spurious. This investigation will require tracing the data to raw data sheets and consulting with field or lab personnel who recorded the data. All raw data sheets, log books and data files will be maintained for future reference. All computer files will be backed up on a daily basis while any data entry or editing procedures are ongoing.

6. LITERATURE CITED

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